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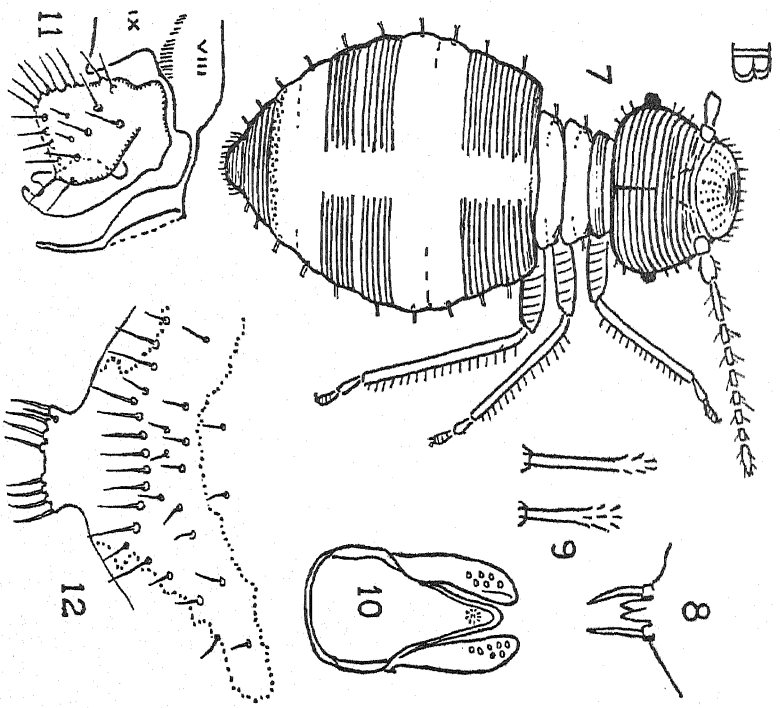
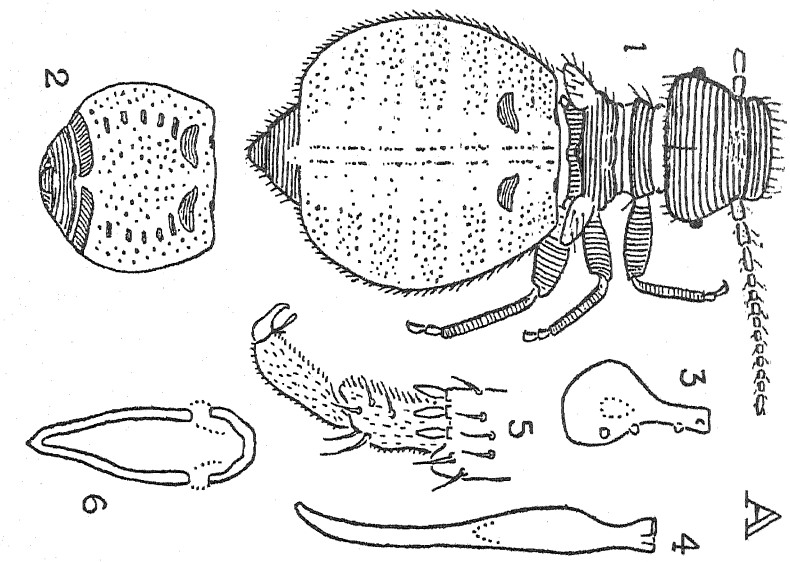


PLATE I.

*Archipsocus biguttatus*

*Nepiomorpha crucifera*

## Two New Psocids from Ceylon

BY

J. V. PEARMAN, F.R.E.S.

---

(With One Plate)

Through the intermediacy of Prof. E. W. MacBride of the Imperial College of Science, London, I have received for identification examples of two hitherto unknown species of Psocoptera collected by Dr. W. Fernando of University College, Colombo. Each is of uncommon interest.

One is noteworthy as being the second Psocid found to reproduce viviparously. The first recorded viviparous species was also discovered by Dr. Fernando in Ceylon; it belongs to the same genus as the one now made known, and has been described elsewhere. An account of its embryology has been published by Dr. Fernando in the *Quarterly Journal of Microscopical Science*.

The other insect dealt with in this paper is remarkable for several peculiarities. It is apterous in both sexes and has retained many nymphal characteristics; further, it has a vestiture of peculiar, erect, plumose setae and a striking colour pattern. It typifies a new genus.

Types of both species will be deposited in the British Museum and co-types in the Colombo Museum.

### 1. *Archipsocus biguttatus*, sp. nov. (Plate I, figs. 1-6)

*Colour.* ♀ : Head, thorax, terminal part of abdomen (except for a small median interruption) and anal lobes very deep brown verging on blackish. Abdomen reddish, darkest laterally, edges of sutures very finely and indistinctly paler; two roughly semicircular, dark brown spots near the base (on the apparent second segment); sockets of cilia finely ringed brown; in darker individuals, through the paler median area runs longitudinally a pair of close, parallel, darker lines. Antennae and palpi brown, a little lighter than the head; legs likewise brown, except trochanters which are yellow.



♂ : Generally similar to ♀ but differing as follows: the two subbasal abdominal spots relatively larger and followed on each side by a row of five smaller, transverse spots; eighth tergite separated from terminal segment by a narrow pale line; ringing of cilia sockets broader.

Nymphs yellow, abdomen a little paler than head and thorax, the two latter parts acquiring a weak brownish tinge in later instars.

*Morphology.* Micropterous. Head broad and flat on upper surface; epicranial suture distinct on vertex, fading out anteriorly; frontal sutures obsolete; frons apparently small and narrow; fronto-clypeal suture broad; clypeus wide and very prominent; mouth parts similar to those figured by Enderlein in *Ann. Mus. Hung.*, I, (1903) Tab. viii, but 'picks' nearly straightly truncate apically, though exhibiting division into a broader outer and a narrower inner tine (Plate I, fig. 4); eyes very small, set a little below hind head angles, hemispherically protruding, moruliform; ocelli nil; antennae a little longer than greatest width of head, of 2 + 11 segments, first flagellar segment (f1) about as long as pedicel, f2-f10 about half that length, subequal but f4 very slightly the longest, f11 a little longer than f1 and with a pointed, subpapilliform apex; sensoria crater-like (placoidal), placed one near the tip of each of segments f1, 4, 6, and 10; antennal ciliation somewhat sparse, subbristly, longest cilia a little longer than f4. Head generally with not very dense, shortish, subbristly cilia, some noticeably longer on clypeus and vertex; whole surface of head with a reticulate cuticular marking, most distinct on frons.

Prothorax of normal Psocid form and proportions; pterothorax much reduced; mesonotum small, with only obsoletely indicated dorsal divisions, transverse, about twice as wide as deep, anteriorly a little narrower than pronotum, bearing a pair of small, narrow winglets each having a length approximately equal to the depth of the mesonotum and being totally devoid of venation; metanotum very shallow, almost linear, and bearing laterally a pair of rounded minute wing vestiges. Thoracic ciliation similar to that of head; of the longer cilia two are noticeable at each side angle of the pronotum; winglets of mesothorax with a few moderately long cilia.

Legs relatively stout, coxae and trochanters proportionately large; hind coxae without 'stridulators'; femora somewhat expanded; fore and mid tibiae about as long as their femora, hind tibia as long as its femur and trochanter together, tibial end-spurs very stout, on fore, mid and hind legs 2, 3, and 3 respectively (Plate I, fig. 5); second segment of tarsus the longer; claw without postapical tooth, furnished with

sucker-like and bristle appendages, the last mentioned indistinct. Ciliation moderately long, not very dense, subbristly but pale and rather indistinct; no ctenidia.

Abdomen large and broad, especially posteriorly; in the female it is then strongly contracted at the fused eighth and ninth tergites, but in the male gradually tapers terminally and the eighth tergite is separate from the ninth; upper and lower surfaces clothed with moderately dense and not very long cilia; the abdominal spots are formed by light cuticular sclerisations; anal lobes small, beset with relatively longish, subbristly cilia; paraprocts without trichobothria, each has a minute cilium near its apex.

Genitalia. ♀: Subgenital plate rounded at apex, lightly sclerosed and pigmented and ciliated uniformly; gonapophyses entirely wanting.

♂: Hypandrium similar to, but broader than, female subgenital plate; phallic sclerite elongate narrow, closed at each end, distal portion broad U-shaped and articulated to the long V-shaped basal part, parameres wanting (Plate I, fig. 6).

Generally, in spite of its small size, a robustly built insect; the thoracic furcae and lateral apodemes are unusually strongly defined, as are the lateral cervical sclerites, which have a distinctive form (Plate I, fig. 8).

Length: whole insect, ♂ 0.87 mm.; ♀ 1.23 mm. (mesothoracic winglets 0.11 mm.).

Ceylon. Colombo, on wall of University College Laboratory, 19 ♀♀, 4 ♂♂ (all micropterous), and several nymphs, March, 1933, (Dr. W. Fernando).

'The insects are web-spinners and viviparous,—but only two or three embryos may be found in a single female. The web is usually spun over a reddish lichen that grows on the wall, and inside a web may be found five or six large individuals and a few small ones.' (W. F.).

Six other species of the genus (one fossil, five recent) have been described. Four of them occur in both macropterous and brachypterous forms; one (*A. neens* Endln.) is known only from brachypterous, and one (*A. fernandi* Pearm.) only from macropterous individuals. The females of all but the last-named have plainly evident, broad, spatulate gonapophyses, the absence of which is a distinguishing feature of the females of the two viviparous species, *fernandi* and *biguttatus*. Irrespective of the condition of the wings and gonapophyses, *biguttatus* can be readily recognized by its sturdy build, and by the shape of its abdomen and the two prominent spots thereon.

So far as can be judged by the descriptions, the present species appears to be most nearly akin to the West African *A. recens*. The latter has equally abbreviated winglets and is the only other species with abdominal markings,—in this case, three longitudinal brown streaks on a yellow ground. The possibility of a near relationship between these two insects is particularly interesting in view of the other Ceylonese viviparous species being morphologically closely allied to the South American *A. brasiliensis* Endln.

Three species of the genus now being known to occur in Ceylon, references to the other two may not be out of place.

*A. recens* Endln., 1903, *Ann. Mus. Hung.*, I, p. 286.

It is the species referred to and figured by Green in 1912, *Spolia Zeylanica*, VIII, p. 71. Macropterous and brachypterous; oviparous. Probably widely distributed in the Orient; recorded from Singapore, Java, and Formosa.

*A. fernandi* Pearm., 1934, *Stylops*, III, p. 112.

Macropterous; viviparous. At present not known to occur outside Ceylon.

## 2. *Nepiomorpha*, gen. nov.

Genotype *N. crucifera*, sp. nov.

Of nymphoid facies and completely apterous in both sexes. Ciliation largely consisting of stout, plumose (spiniferous), setae (at least in the type species). Antennae reduced (segments 2 + 8/9). Tarsi of two segments; claw with one postapical tooth. Paraprocts with apical duplex spines. Mouth parts and genitalia of *Reuterella* type.

Allied to *Reuterella* Enderlein, 1901, differing in the following respects:—ciliation, number of antennal segments, thoracic structure, apterous condition of male, paraproct spines, and in the details of the 'pick' and the genitalia.<sup>1</sup>

### *Nepiomorpha crucifera*, sp. nov. (Plate I, figs. 7-12)

*Colour.* Head very dark brown, a little paler on cheeks; eyes black; antennae,—scape and pedicel creamy or whitish, flagellum light brown, darkening towards tip; clypeus ochraceous or yellowish brown with converging light brown striations (resolvable into dots) and a brown clouding on anterior median portion; epistoma whitish; labrum dark brown; maxillary palpi ochraceous, a little browned at tip. Thorax

<sup>1</sup> It may be debatable whether the differentiation should be taken to imply full generic or only sub-generic separation; in the past, genera have been separated by less marked divergencies. The general question will be considered in a forthcoming paper on Psocid morphology.

very pale sulphur yellow to whitish with some brown tingeing on pronotum. Abdomen above with alternate, subequal, broad bands,—three dark brown and two pale sulphur yellowish or whitish; by the interruption medially of the basal and intermediate brown bands there is formed the pattern of a pale yellowish or whitish cross arising from a similarly coloured bar, standing out against a dark background; anal lobes wholly dark brown; beneath whitish; genitalia brown. Legs very light brown or ochraceous, femora and terminal segment of tarsi darker.

*Morphology.* Head rounded; epicranial suture distinct, frontal sutures faint; frons narrow, reticulately marked; clypeus rounded, tumid, rather large; labrum transverse, with nearly straight sides; eyes very small, moruliform with few facets, hemispherically projecting; ocelli wanting; antennae about one and a half times as long as greatest head width, f1 nearly of the same length as scape and pedicel together, f2-f4 about half that length, subequal, f5 and f6 shorter, f7 still shorter, f8 and f9 amalgamated into an elongate, ovoid terminal segment nearly as long as f1, the intersegmental division only weakly, sometimes incompletely, marked; there are indications of a small craterous sensorium at about the middle of f1 and the tip of f4; mouth parts generally as in *Reuterella helvimacula* Endln. but the 'pick' terminating in two stubs (similar to that of *Archipsocus biguttatus* above, see Plate I, fig. 4).

Thorax very small, all segments annular and adherent (as in nymphal Psocids). Legs of normal form, but trochanters rather large, tibiae without end-spurs, the latter replaced by undifferentiated bristles; hind coxae without 'stridulatory' structures; basitarsus very slightly shorter than terminal segment; claw with a very small postapical tooth and a long, fine, colourless basal bristle. No ctenidia on tibiae or tarsi.

Abdomen ovoid, basal and terminal segments sclerosed and darkened; anal lobes of usual form with scattered cilia which are longest in the female; paraprocts with a pale 'sensory suchion' which however, has no trichobothria but about five longish simple cilia in the female and one very long cilium and several short spiniferous setae in the male, at the apex of each paraproct in both sexes a pair of short, stout, close-set spines between two longer simple spines (stronger in the male,—Plate I, fig. 8).

Genitalia. ♀: Subgenital plate lightly sclerosed and pigmented as in Plate I, fig. 12, apex produced into a short, stumpy projection which bears terminally a row of 8/9 strong bristles (interrupted medially),

across the disc longer and finer cilia; anterior gonapophyses proceeding from a longish, slender stalk and somewhat angularly produced basally, at first expanded, in terminal half narrow and styliform; inner lobe of posterior gonapophyses broader, terminating in two nearly equal, short extensions and attached by a narrow stalk to the broad, spatulate outer lobe which is beset with long, subbristly cilia (Plate I, fig. 11).

♂ : Hypandrium lightly sclerosed and pigmented, elliptically rounded at apex, beset with scattered longer and shorter cilia; phallic sclerite transversely closed behind, parameres large, spoon-shaped, with pore-like spots, inner processes fused at their tips and there enclosing (in the specimen dissected) a round, spinulose 'radula' (Plate I, fig. 10).

Body ciliation. A striking feature is provided by the stout, but comparatively weak, erect, blunt setae having minute spiny projections on the shaft, especially towards the tip (Plate I, fig. 9). Most are from .04 to .05 mm. long. They are distributed as follows: scattered over epicranium, frons and proximal part of clypeus, in a single row across meso- and metanota and each abdominal tergite. Down the outer side of each tibia runs a row of more slender and simpler, longish setae, only a few near the knee exhibiting traces of spiny processes. Elsewhere the ciliation is normal, scattered, fine, and of various lengths.

Length: whole insect, ♂ 0.975 mm.; ♀ 1.33 mm. (somewhat variable).

Ceylon: Colombo, on wall of University College Laboratory, about 100 ♂♂ and 5 ♀♀, March, 1933 (Dr. W. Fernando).

'Do not spin a web, but live in groups. All the specimens sent belonged to a single group or "colony"' (W. F.).

In the reduced number of antennal segments, the simple structure of the thorax, and its winglessness, the insect has retained conditions common to the earlier instars of nymphs of the group to which it belongs. The curious duplex paraproctal spines are also nymphal features that hitherto have been found to persist only in the apterous adult females of the (European) genus *Pseudopsocus* Kolbe (*nec* Chapman). No other species is known to possess, at any stage of its development, the peculiar spiniferous setae. Somewhat similar, but relatively longer and pointed bristles occur on the wings (chiefly near the humeral angle) of many species of Lepidopsocidae (see Enderlein, 1906, *Spolia Zeylanica*, IV (pt. xiv-xv), Plate E, fig. 51). Loss of wings in the female is not at all uncommon in Psocids, but—excepting the Liposcelidae, in which the majority of species are completely apterous—in no other group have entirely wingless males been detected hitherto.

## EXPLANATION OF PLATE I

## PLATE I

A. *Archipsocus biguttatus*, sp. nov.

1. Female (the head should have been shown a little wider).
2. Male abdomen.
3. Cervical lateral sclerite.
4. Pick.
5. End of hind leg.
6. Phallic sclerite, ♂.

B. *Nepiomorpha crucifera*, gen. et. sp. nov.

7. Female.
8. Paraproct spines ♂.
9. Plumose setae.
10. Phallic sclerite, ♂.
11. Gonapophyses ♀ (viii, ix, prolongations of eighth and ninth tergites).
12. Subgenital plate ♀, showing outline of pigmented area.

In figs. 1 and 7 ciliation shown only at sides; in 2 omitted.

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## The Tridactylidae and Gryllidae of Ceylon

BY

L. CHOPARD, D.Sc.

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(With Twenty-two Text Figures)

The fauna of the Gryllodea (including Tridactylidae) of Ceylon is known through recent investigations only, and chiefly through those of Mr. E. E. Green and Mr. G. M. Henry. In 1925, I published a first list including sixty-one species known in the Island; since then, I have received very important collections from Mr. G. M. Henry, Colombo Museum, the study of which has considerably increased our knowledge of this fauna. It is a very agreeable task for me to thank him for having allowed me to study such rich, well-collected and beautifully preserved material. The specialist's task is as unpleasing when he has to deal with collections collected at hazard, in which the species are often represented by one example only, as it is made easier and becomes agreeable when he has at disposal large series of individuals of both sexes of methodically collected specimens.

The list which I can give to-day contains ninety-eight species of Tridactylidae and Gryllidae and it must very nearly include the total number of species of the group to be found in Ceylon. If a few additions should be made in future, they will certainly not change the general inferences which may be drawn from our present knowledge.

If we except a few species which are almost cosmopolitan in warm countries and for that reason present no geographic interest, the Gryllodea of Ceylon may be distributed in four groups: (1) about a dozen species very widely spread throughout tropical Asia and presenting therefore small interest from a zoo-geographical point of view; (2) twenty-three species which are also found in continental India especially South India; (3) seven or eight species presenting Malayan affinities but which may be also found in India; most of the species of the two latter groups belong to widely dispersed genera such as *Gryllus*, *Pteronemobius*, *Gymnogryllus*, *Scapsipedus*, etc.; (4) finally, and this is the most interesting point, a considerable number of species which are



known from Ceylon only. These species number no less than fifty-four; of course among them a certain number will eventually be found in neighbouring countries, especially India, but there is no doubt that the Ceylonese fauna shows a very marked character of endemism. Many of these last species are besides particularly interesting; let us quote among others the genera *Nemobiodes*, *Stephoblemmus*, *Scapsipedoides*, *Hemilandreva*, *Paranaxipha*, *Homalogryllus*, *Derec-aotus*, *Luzaropsis*, *Myrmegryllus*. The last one is all the more curious as the sub-family Myrmecophilinae shows a remarkable uniformity throughout the world. It may be noted that the Ceylonese fauna is particularly rich in *Landreva* (four species), in Trigonidiinae, in *Arach-nomimus* (three species), in *Madasumma* (five species), in *Euscyrtus* (five species). All these groups present Malayan rather than Indian affinities; such is also the case with *Pentacentrus*, *Mnesibulus*, *Heterotrypus* and finally with *Cardiodactylus praecipuus* whose presence in Ceylon, if confirmed, is really very unexpected. On the other hand *Seychellesia ceylonica* must be signalized as belonging to a genus which has hitherto been known only from the Seychelles Islands.

It may be seen as a whole that the Ceylonese fauna is far from being purely an Indian one. Although the Indian elements are rather numerous, they do not form even the majority and most of the characteristic types of Ceylon present rather Malayan affinities. Lastly, the presence of a species of the genus *Seychellesia* is an interesting feature which cannot be interpreted otherwise than as being a relic of the ancient Indo-Malgash continent.

The following table gives the distribution of the Ceylonese Gryllodea with more details.

TABLE I.—Distribution of Ceylonese Gryllodea

	En- demic	Indian species	Malay species	Asiatic species	Ubi- quists
<i>Tridactylus variegatus</i>	—	—	—	—	+
— <i>nigroaeneus</i>	—	+	—	—	—
— <i>nigripennis</i>	+	—	—	—	—
— <i>curtus</i>	+	—	—	—	—
— <i>quadrifaculatus</i>	+	—	—	—	—
— <i>opacus</i>	—	—	—	+	—
— <i>thoracicus</i>	—	+	+	—	—
<i>Gryllotalpa africana</i>	—	—	—	—	+
<i>Brachytrypes orientalis</i>	—	+	—	—	—
<i>Gymnogryllus erythrocephalus</i>	—	+	+	—	—
— <i>humeralis</i>	—	+	—	—	—
<i>Itaropsis tenellus</i>	—	+	—	—	—

TABLE I.—*contd.*

	En- demic	Indian species	Malay species	Asiatic species	Ubi- quists
<i>Gryllus bimaculatus</i>	—	—	—	—	+
<i>Gryllulus testaceus</i>	—	+	+	+	—
— <i>mitratus</i>	—	+	+	+	—
— <i>configuratus</i>	—	+	—	—	—
— <i>flavus</i>	+	—	—	—	—
— <i>confirmatus</i>	—	+	+	+	—
— <i>bucharicus</i>	—	+	—	—	—
— <i>brevicauda</i>	+	—	—	—	—
— <i>blennus</i>	—	+	+	—	—
— <i>pallipes</i>	+	—	—	—	—
<i>Gryllodes sigillatus</i>	—	—	—	—	+
— <i>supplicans</i>	+	—	—	—	—
<i>Gryllopsis falconetti</i>	—	+	—	—	—
<i>Nemobiodes laeviceps</i>	+	—	—	—	—
— <i>nigrocephalus</i>	+	—	—	—	—
<i>Cophogryllus martini</i>	—	+	—	—	—
<i>Scapsipedus aspersus</i>	—	+	+	+	—
— <i>ceylonicus</i>	+	—	—	—	—
<i>Coiblemmus compactus</i>	—	+	—	—	—
<i>Loxoblemmus equestris</i>	—	+	+	+	—
— <i>longipalpis</i>	+	—	—	—	—
<i>Stephoblemmus humbertiellus</i>	+	—	—	—	—
<i>Scapsipedoides macrocephalus</i>	+	—	—	—	—
— <i>apterus</i>	+	—	—	—	—
<i>Landreva clara</i>	+	—	—	—	—
— <i>subaptera</i>	+	—	—	—	—
— <i>insignis</i>	—	+	—	—	—
— <i>angustifrons</i>	+	—	—	—	—
<i>Hemilandreva lamellipennis</i>	+	—	—	—	—
<i>Paranemobius pictus</i>	—	+	—	—	—
<i>Pteronemobius concolor</i>	—	+	+	+	—
— <i>birmanus</i>	—	+	—	—	—
— <i>vagus</i>	—	+	+	+	—
— <i>taprobanensis</i>	—	+	+	+	—
— <i>fascipes</i>	—	+	+	+	—
— <i>csikii</i>	—	+	—	+	—
— <i>bicolor</i>	—	+	—	—	—
<i>Scottia ceylonica</i>	+	—	—	—	—
<i>Trigonidium cicindeloides</i>	—	—	—	—	+
— <i>humbertianum</i>	—	+	+	—	—
<i>Metioche unicolor</i>	—	—	+	—	—
<i>Metiochodes greeni</i>	+	—	—	—	—
— <i>trilineatus</i>	+	—	—	—	—
<i>Amusurgus oedemeroides</i>	—	+	+	—	—
— <i>speculifer</i>	+	—	—	—	—
<i>Paranazipha ornaticipes</i>	+	—	—	—	—
<i>Trigonidomorpha fuscifrons</i>	+	—	—	—	—
<i>Homoeozipha lycoides</i>	—	+	+	+	—
<i>Anazipha pubescens</i>	+	—	—	—	—
— <i>longipennis</i>	—	—	—	—	+
— <i>henryi</i>	+	—	—	—	—
<i>Myrmecophila escherichi</i>	+	—	—	—	—
<i>Myrmegryllus pilipes</i>	+	—	—	—	—
<i>Cycloptiloides orientalis</i>	—	—	+	—	—
<i>Ornebius guerini</i>	—	+	—	—	—
— <i>varipennis</i>	+	—	—	—	—

TABLE I.—*contd.*

	En- demic	Indian species	Malay species	Asiatic species	Ubi- quists
<i>Derectaotus ceylonicus</i>	+	—	—	—	—
— <i>henryi</i>	+	—	—	—	—
— <i>palpatus</i>	+	—	—	—	—
<i>Ectatoderus ceylonicus</i>	+	—	—	—	—
<i>Pentacentrus pulchellus</i>	+	—	—	—	—
<i>Homalogryllus depressus</i>	+	—	—	—	—
<i>Oecanthus indicus</i>	—	+	+	—	—
— <i>rufescens</i>	—	+	+	—	—
— <i>henryi</i>	+	—	—	—	—
<i>Arachnomimus nietneri</i>	+	—	—	—	—
— <i>bicolor</i>	+	—	—	—	—
— <i>annulicornis</i>	+	—	—	—	—
<i>Luzaropsis ferruginea</i>	+	—	—	—	—
— <i>henryi</i>	+	—	—	—	—
<i>Seychellesia ceylonica</i>	+	—	—	—	—
<i>Heterotrypus vicinus</i>	+	—	—	—	—
— <i>elegans</i>	+	—	—	—	—
<i>Cardiodactylus praecipuus</i>	+	—	—	—	—
<i>Madasumma marginipennis</i>	+	—	—	—	—
— <i>greeni</i>	+	—	—	—	—
— <i>albonotata</i>	+	—	—	—	—
— <i>valida</i>	+	—	—	—	—
— <i>varipennis</i>	+	—	—	—	—
<i>Mnesibulus pallipes</i>	+	—	—	—	—
<i>Euscyrtus hemelytrus</i>	—	+	+	+	—
— <i>concinus</i>	—	+	+	+	—
— <i>necydaloides</i>	+	—	—	—	—
— <i>laminifer</i>	+	—	—	—	—
— <i>perforatus</i>	+	—	—	—	—
<i>Patiscus quadripunctatus</i>	—	+	—	—	—

## Family Tridactylidae

One genus only of this family is represented in the Ceylonese fauna.

Genus *Tridactylus* Oliv. 1789

## KEY TO THE SPECIES

1. Posterior tibiae without lamellae . . . . . 2
- Posterior tibiae provided with lamellae . . . . . 3
2. Pronotum entirely black . . . . . *curtus*
- Pronotum lined with white in front and adorned with four whitish spots on the disc . . . . . *quadrimaculatus*
3. Posterior metatarsi articulated, longer than the superior apical spurs . . . . . *thoracicus*
- Posterior metatarsi tuberculiform . . . . . 4
4. General coloration dull blackish brown; head and pronotum covered with an erect whitish pubescence . . . . . *opacus*

- General coloration black or bronzed, shining;  
almost completely glabrous . . . . . 5
- 5. Internal margin of the eyes parallel, their  
inferior angle as much apart as the superior angle . . . . . 6
- Internal margin of the eyes converging, the  
distance between their superior angles not  
so wide as between the inferior angles;  
wings long, blackish . . . . . *nigripennis*
- 6. Very shining; wings short . . . . . *variegatus*
- Somewhat shagreened; wings long, whitish . . . . . *nigroaeneus*

### 1. *Tridactylus variegatus* (Latr.)

*Xya variegata* Latreille, 1809. *Gen. Crust. Ins.*, IV, p. 383

*Xya japonica* Haan, 1842. *Temm. Verh. Orth.*, p. 238

*Tridactylus riparius* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 48, pl. 11 (IV),  
fig. 11

*Tridactylus flavomaculatus* Matsumura, 1911. *Mém. Soc. Ent. Belg.*, p. 131

*Tridactylus japonicus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 506

Colombo, X-1926; Battaramulla, X-1929; Mihintale, VI-1927; Trincomalee, VII-1927; Matale, XII-1928; Sigiriya, Peradeniya, Kesbawa, Pundalu-oya.

I have examined a great number of *Tridactylus* from Europe and Asia and I cannot find any reliable character to separate *T. variegatus* from *T. japonicus*. I am convinced that the same species is found all over this enormous region.

### 2. *Tridactylus nigroaeneus* Walk.

*Tridactylus nigroaeneus* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, suppl., p. 1

Colombo, X-1926, XI-1928, I-1929, V-1929, VI-1929; Kotiyagoda, XII-1928.

Under this name a form can be distinguished which looks very much like *variegatus* but which, nevertheless, is easily recognized by a general aspect not so shining, the surface of the body being very finely alutaceous, nearly silky in its appearance. Besides, the macropterous forms which are very scarce in *variegatus*, seem almost the rule in the present species, the whitish wings extending nearly to the apex of abdomen. The general coloration is also usually darker, the posterior femora being blackish without any light markings; but, owing to the great variability of colours in this group, this can hardly be used as a specific character.

3. *Tridactylus nigripennis*, sp. nov.

*Tridactylus nigroaeneus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 506  
(nec Walker)

Type: Bibile, 20-VII-1929, 1 ♀. Cotype: Kitulgala, 8-IV-1927, 1 ♀.

Size and general habitus of *T. variegatus*; not quite so shining. Head black; internal margin of the eyes rather strongly converging upwards, so that the superior angles are much less distant than the inferior ones; orbits finely lined with yellow. Face black with a fine erect whitish pubescence. Palpi and antennae black.

Pronotum blackish, a little shining, presenting series of hollow points more numerous than in *variegatus*, chiefly in the posterior part of lateral lobes; these are narrowly bordered with yellowish and their posterior angle is rather strongly projecting. Abdomen blackish above, yellowish beneath; subgenital plate presenting a very small notch in the middle of the posterior margin. Cerci and anal processes brownish.

Legs blackish, spotted with yellow as in *variegatus*. Posterior tibiae with four external, three internal lamellae; metatarsi tuberculiform.

Elytra similar in shape to those of *variegatus*; brown, with a basal spot and a sutural band yellow. Wings very long, somewhat longer than the abdomen, blackish, with a small yellow band above in the exposed part, their internal part iridescent.

Length of body 5.5 mm.

This species looks very much like *variegatus*, but differs from it in the shape of the eyes and in the length of the wings; it also differs from *nigroaeneus* in its more shining aspect and its wings which are blackish instead of whitish.

4. *Tridactylus curtus*, sp. nov.

Type: Wellawaya, 28-IV-1931, 1 ♂. Cotype: Bintenne, X-1928, 1 ♂.

Very small, shining black. Head black, the eyes narrowly bordered with yellow; forehead very wide, marked with a scarce, strong punctuation; face brown, clypeus presenting a few hollow points. Palpi and antennae brown.

Pronotum very wide and convex; disc blackish brown, finely shagreened with a few very scarce puncturations; lateral lobes colorous. Scutellum very visible between the elytra. Abdomen brown above, yellowish beneath, the sternites regularly and rather strongly

punctured, subgenital plate with posterior margin truncated, rounded angles, 10th tergite deeply furrowed in the middle and bearing small piliferous tubercles on either side of the furrow; superior anal valves presenting a small hook directed upwards, their process yellowish. Cerci with 1st joint brown, 2nd one yellowish.

Anterior legs yellowish, median ones brownish, the median tibiae short and wide. Posterior femora very short, blackish brown, shining; posterior tibiae bearing six rather strong denticles on each margin, but no lamellae (Fig. 1). Metatarsi tuberculiform.

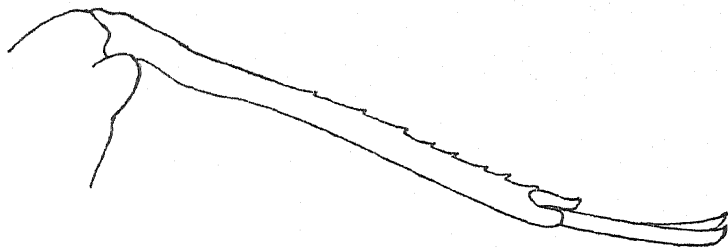


Fig. 1. *Tridactylus curtus*, sp. nov., posterior tibia

Elytra very short, blackish brown, their surface rather strongly shagreened. Wings quite aborted.

Length of body 4.5 mm.

At first sight, this small species looks rather like *T. variegatus*; but, besides the absence of tibial lamellae, it differs from it in the much shorter general shape, the very convex pronotum, the scutellum visible between the elytra. These features also distinguish it from *T. indicus* Chop., from continental India, the posterior tibiae of which are also destitute of lamellae. The blackish, uniform, rather shining coloration with lighter legs seems rather characteristic of the present species.

##### 5. *Tridactylus quadrimaculatus*, sp. nov. (Fig. 2)

Type: Bintenne, X-1928, 1 ♀.

Very small, black with a few yellow spots. Head black, adorned with two yellow spots near the superior angle of the eyes, shining, with a few feebly marked hollow points; forehead very wide, the internal margin of the eyes being nevertheless somewhat converging; face black, facial shield presenting a few hollow points. Palpi brown. Antennae brown with four last joints yellow.

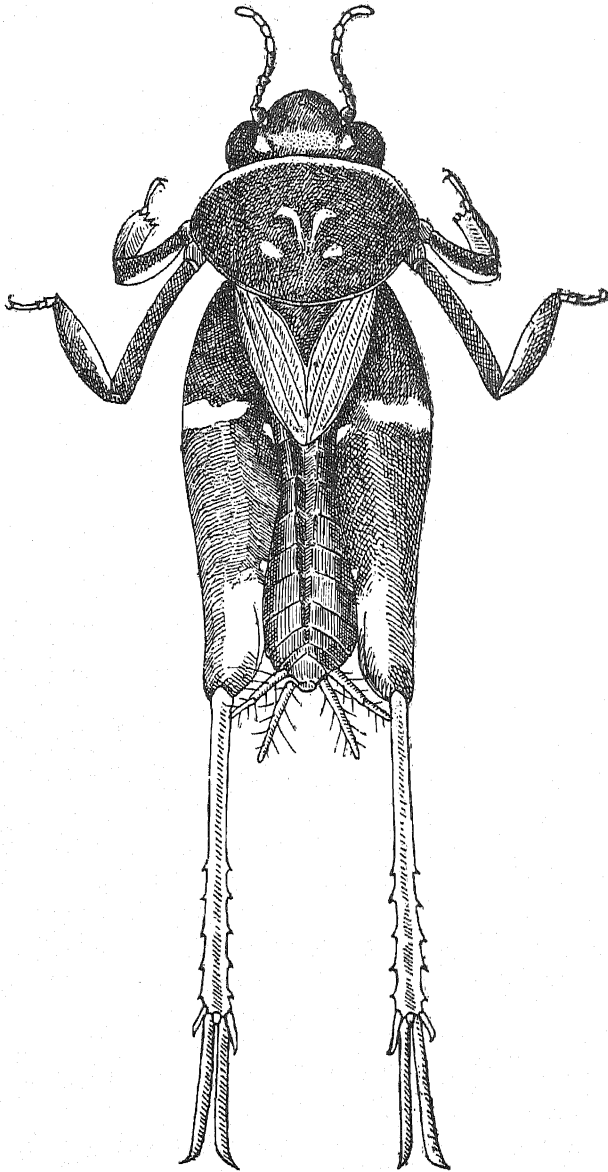


Fig. 2. *Tridaotylus quadrimaculatus*, sp. nov.

Pronotum strongly transverse, with convex anterior and posterior margins; disc very strongly convex, blackish brown, finely shagreened, adorned with a narrow yellow band along the anterior margin and four small yellow spots near the middle; lateral lobes with nearly straight inferior margin, spotted with yellow in the anterior and posterior angles, and presenting a few big hollow points. Scutellum visible between the elytra. Abdomen blackish above, rufous brown beneath; subgenital plate with posterior margin very slightly notched in the middle. Cerci and anal appendages yellowish brown.

Anterior legs yellowish; intermediate ones brownish, the tibiae narrowing towards the apex, spotted with yellow near the anterior margin. Posterior femora very short, blackish brown with a yellow spot a little before the middle; tibiae armed with five rather strong denticles on each margin, but bearing no lamellae. Metatarsi tuberculiform.

Elytra very short, blackish brown, shagreened. Wings very short.

Length of body 4.5 mm.

This species looks very much like the preceding one, but differs from it in the coloration and the shape of the pronotum, which is more strongly transverse and more convex.

#### 6. *Tridactylus opacus* Walk.

*Tridactylus opacus* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, suppl., p. 1.

Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 506

*Tridactylus nitobae* Shiraki, 1911. *Mon. Gryll. Formose*, p. 15, pl. 1, fig. 1

Peradeniya, Nawalapitiya.

This small species is easily recognized by its dull brown coloration and the rather abundant erect pubescence which covers the pronotum.

#### 7. *Tridactylus thoracicus* Guér.

*Tridactylus thoracicus* Guérin, 1844. *Icon. R. An.*, III, p. 336. Chopard, 1925.

*Ann. Mag. Nat. Hist.* (9) XV, p. 506

Peradeniya, Kandy.

This species is widely distributed in the Indo-Malaysian region.

### Family Gryllidae

#### KEY TO THE SUB-FAMILIES

- |  |                            |
|--|----------------------------|
| 1. Anterior legs short, presenting a special con-<br>formation for digging | ..... <i>Gryllotalpinæ</i> |
| — Anterior legs normally formed  | ..... 2                    |



2. Body short, oval; antennae and cerci relatively short; posterior femora massive scarcely one and a half times as long as wide; myrmecophilous insects . . . . . *Myrmecophilinae*
- Body not so short; antennae long, setaceous, cerci long; posterior femora lengthened . . . . . 3
3. Tarsi compressed, with small 2nd joint . . . . . 4
- Tarsi depressed, chiefly the 2nd joint, which is cordiform in shape . . . . . 10
4. Posterior tibiae with serrulated margins, without spines . . . . . 5
- Posterior tibiae armed with spines on the superior margins . . . . . 6
5. Body covered with scales; apterous or presenting short, membranaceous elytra in the male sex . . . . . *Mogoplistinae*
- Body glabrous or feebly pubescent, winged . . . . . *Scleropterinae*
6. Posterior tibiae smooth between the spines . . . . . 7
- Posterior tibiae serrulated between the spines . . . . . 9
7. Posterior tibiae armed with fixed spines . . . . . 8
- Posterior tibiae armed with movable, pubescent spines . . . . . *Nemobiinae*
8. Head globular; antennae inserted above the middle . . . . . *Gryllinae*
- Head flattened in front; antennae inserted below the middle . . . . . *Pentacentrinae*
9. Head lengthened, horizontal. Slender insects with very long posterior femora; elytra transparent . . . . . *Oecanthinae*
- Head short, vertical. More robust insects with usually long legs but posterior femora strongly swollen at base . . . . . *Phalangopsinae*
10. Posterior tibiae non-serrulated, armed with three spines on each margin. Very small, delicate insects . . . . . *Trigonidiinae*
- Posterior tibiae serrulated between the spines . . . . . 11
11. Posterior tibiae with long apical spurs, the externo-median one longer than the other two; posterior metatarsus lengthened . . . . . 12
- Posterior tibiae with very short, nearly equal external spurs; posterior metatarsus short . . . . . *Podoscirtinae*
12. Head big with wide frontal rostrum . . . . . *Eneopterinae*
- Head small, with narrow frontal rostrum . . . . . *Itarinae*

All the sub-families except *Scleropterinae* are represented in the Ceylonese fauna.

## Sub-family GRYLLOTALPINAE

This sub-family includes only the mole-crickets which are too well known to deserve a special description. One species only is known from Ceylon.

Genus *Gryllotalpa* Latr. 18028. *Gryllotalpa africana* Beauv.

*Gryllotalpa africana* Beauvois, 1805. *Ins. Afr. Amér.*, p. 229, pl. 2 c, fig. 6

Kandy.

## Sub-family GRYLLINAE

This sub-family contains those species which are commonly known as crickets.

## KEY TO THE GENERA

1. Posterior tibiae serrulated at base, before the insertion of spines . . . . . 2
- Posterior tibiae non-serrulated . . . . . 3
2. Elytra of male truncated at apex, with fairly well developed neurulation, speculum visible . . . . . *Landreva*
- Elytra of male very short, triangular, with very confused neurulation, no visible speculum . . . . . *Hemilandreva*
3. Posterior femora long, as long as tibia and tarsus united; ocelli disposed on a straight line; body glabrous . . . . . 4
- Posterior femora equalling no more than tibia and metatarsus united; ocelli disposed as a triangle; body usually more or less pubescent . . . . . 5
4. Anterior metatarsi very short; very large species with very short ovipositor . . . . . *Brachytrypes*
- Anterior metatarsi moderately long; anterior and median tibiae ciliated with long hairs; less stout species with longer ovipositor . . . . . *Gymnogryllus*
5. Both sexes with convex face . . . . . 6
- Face more or less flattened in the male . . . . . 12
6. Supero-internal spur of posterior tibiae longer than the median one; body almost glabrous . . . . . *Gryllus*
- Supero-internal spur of posterior tibiae shorter or rarely equal to the median one; body usually pubescent . . . . . 7
7. Both sexes apterous; anterior tibiae non-perforated . . . . . *Cophogryllus*
- Elytra well developed, in the male sex at least; anterior tibiae perforated with one or two foramina . . . . . 8

- |  |       |                        |
|--|-------|------------------------|
| 8. Head with narrow frontal rostrum  | ..... | 9                      |
| — Head with wide frontal rostrum   | ..... | 10                     |
| 9. Head somewhat flattened; body pubescent;<br>ovipositor long   | ..... | <i>Gryllodes</i>       |
| — Head rounded; elytra very ample in male;<br>ovipositor abortive  | ..... | <i>Itaropsis</i>       |
| 10. Elytra of male with well developed speculum  | ..... | 11                     |
| — Elytra of male with speculum indistinct or<br>small, displaced towards the apex; <i>Nemobius</i> -like species | ..... | <i>Nemobiodes</i>      |
| 11. Body very convex; female with short, lateral<br>elytra   | ..... | <i>Gryllopsis</i>      |
| — Body not so convex; female with more or less<br>developed elytra, never reduced to small<br>lateral lobes      | ..... | <i>Gryllidus</i>       |
| 12. Both sexes apterous  | ..... | <i>Scapsipedeoides</i> |
| — Elytra present in both sexes   | ..... | 13                     |
| 13. Male with flattened or somewhat concave face,<br>but forehead without any prolongation                       | ..... | 14                     |
| — Face of the male strongly flattened; forehead<br>more or less prolonged  | ..... | 15                     |
| 14. Frontal rostrum convex as in the genus<br><i>Gryllus</i>   | ..... | <i>Scapsipedus</i>     |
| — Frontal rostrum of male subangulate, some-<br>what prominent, with a small apical depres-<br>sion              | ..... | <i>Coiblemmus</i>      |
| 15. Frontal rostrum of male projecting, but<br>simply angular  | ..... | <i>Loroblemmus</i>     |
| — Frontal rostrum of male presenting a mem-<br>branaceous process  | ..... | <i>Stephoblemmus</i>   |

### Genus *Brachytrypes* Serv. 1839

#### 9. *Brachytrypes orientalis* (Burm.)

*Gryllus orientalis* Burmeister, 1838. *Handb. Ent.*, II, p. 735

Balangoda, IV-1926.

This species is the smallest in the genus and does not surpass the size of a big *Gryllus* (24-26 mm.). It is very close to *B. portentosus* which is very common in India, but much smaller; the neururation of the male is very similar but presents a difference, which seems constant, in the apical part of elytra, which is divided into short, nearly square, areolae, whereas in *portentosus*, these areolae are very long. Ovipositor relatively shorter and thicker with shorter apical valves (cf. Chopard, 1928, *Rec. Ind. Mus.* XXX, p. 6, fig. 9-10).

Genus **Gymnogryllus** Sauss. 1877

## KEY TO THE SPECIES

- Rather small size (12-15 mm.); pronotum entirely black; head reddish (blackish in a variety) . . . . . *erythrocephalus*
- Size medium (20-22 mm.); pronotum rufous with lateral lobes widely yellowish; head brown . . . . . *humeralis*

10. **Gymnogryllus erythrocephalus** (Serv.)

*Gryllus erythrocephalus* Serville, 1839. *Ins. Orth.*, p. 339

*Gymnogryllus erythrocephalus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 508

Marai Villu, III-1933; Peradeniya.

Var. *melanocephalus* Chopard, 1931. *Ark. f. Zool.*, 23 A, No. 9, p. 7

Marichchukkadi, III-1933.

The typical form of this small species is readily recognizable in its uniformly black coloration with reddish head. The variety *melanocephalus*, in which the head is as black as the body, has been described from Sumatra; it seems mixed with the typical form but is not so common. The species is commonly found in India and Indo-Malaysia.

11. **Gymnogryllus humeralis** (Walk.)

*Gryllus humeralis* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, suppl., p. 5

*Gymnogryllus humeralis* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 508

Madola near Opanake, II-1933; Kandy, Peradeniya, Chilaw.

This species is also easy to distinguish by its coloration and shining general aspect. It is found only in the southern part of India and Ceylon.

Genus **Itaropsis** Chop. 192512. **Itaropsis tenellus** (Walk.)

*Gryllus tenellus* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 37 (♀ non ♂)

*Gryllus parviceps* Walker, 1871. *Op. cit.*, V, suppl. p. 8 (♂)

*Itaropsis parviceps* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 510

*Anurogryllus tenellus* Chopard, 1925. *Loc. cit.*, p. 508, fig. 2

Battaramulla, I-1930; Mousakande, Gammaduwa, XI-1929; Uva Highlands, Bandarawela, I-1933; Matale, XI-1932; Peradeniya, Kandy, Ratnapura.

This species shows a rather wide variation in size (14 to 18 mm.) and is represented by macropterous and micropterous specimens. There is no doubt that *Gryllus tenellus* is the female of *Gryllus parviceps*; the first one was put by myself in the American genus *Anurogryllus* on account of its rudimentary ovipositor; the second one was placed by Saussure in a special division of his wide genus *Gryllodes*. The species is really a very remarkable one and deserves to constitute a special genus which is to be placed in the neighbourhood of *Anurogryllus* and *Gymnogryllus* among the Brachytrypites, although the supero-internal spur of the posterior tibiae is much shorter than the median one. The macropterous form sometimes exhibits a small tympanum at the internal face of anterior tibiae.

Genus **Gryllus** L. 1758 (**Liogryllus** Sauss. 1877)

13. **Gryllus bimaculatus** De Geer

*Gryllus bimaculatus* De Geer, 1773. *Mém. Ins.*, III, p. 521, pl. 43, fig. 4

*Acheta bimaculata* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 509

Kandy, Maha-Illupalama.

This species is one of the most common and widely spread Gryllids in all the tropical and subtropical regions of Africa and Asia. It might be considered as a *Gryllulus* rather than a *Gryllus* as the supero-internal spur of posterior tibiae is not longer than the median one. In its typical form, the species is very easy to recognize, all the body being shining black with two yellow marks at base of the elytra; the head is always small and the pronotum somewhat constricted in front, even in the male.

Genus **Gryllulus** Uvarov 1935 (**Gryllus** Sauss. 1877 et auct.)

Nine species only of the genus *Gryllulus* have been recorded from Ceylon, this number being much inferior to that of the forms which are known from India. It is rather surprising to notice that the common house cricket, *Gryllulus domesticus* (L.), has never been recorded in the island. It is possible that this species may be found in Ceylon as well as certain forms from South India. I have been compelled to suppress two species which I had recorded in the list I gave in 1925, viz., *Gryllulus angustulus* described by Walker from Bombay and *Gryllulus conspersus* (Schaum), for which I have found no exact locality.

## KEY TO THE SPECIES

1. Larger size (18-26 mm.); male elytra with 4-5 oblique veins; ovipositor as long as the body . . . . . 2
- Medium or small size; male elytra with 2-3 oblique veins; ovipositor shorter than the body . . . . . 3
2. General coloration uniformly testaceous; head yellowish testaceous without well marked yellow band along the eyes . . . . . *testaceus*
- General coloration darker; head brown above with a very neat yellow band along the internal margin of the eyes . . . . . *mitratus*
3. Small species (10-11 mm.); blackish with fulvous legs . . . . . 4
- Medium size species (12-16 mm.); more or less varied with brown and yellowish . . . . . 5
4. Pronotum slightly enlarged in front; lateral field of the elytra with regularly spaced veins . . . . . *pallipes*
- Pronotum with parallel sides; lateral field of the elytra with widely separated veins . . . . . *blennus*
5. Somewhat depressed species, with very wide pronotum; head brown turning to rufous on the occiput, with four longitudinal light bands, very short and feebly visible . . . . . *configuratus*
- Species with not so depressed body; pronotum not so strongly transverse . . . . . 6
6. Medium size (12-14 mm.); very uniform light fulvous coloration . . . . . *flavus*
- Smaller size (11-12 mm.); not so uniform coloration; head adorned with yellow bands, thorax varied with brown and yellowish . . . . . 7
7. Head big, brown; forehead without a transverse yellow band; ovipositor abnormally short . . . . . *brevicauda*
- Head not so big; forehead with a yellow band between the antennae; ovipositor normal . . . . . 8
8. Lateral field of elytra with parallel and feebly distant veins . . . . . *bucharicus*
- Lateral field of elytra with irregular, very distant veins . . . . . *confirmatus*

14. *Gryllulus testaceus* (Walk.)

*Gryllus testaceus* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 31. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 509

Kandy, Puttalam, Peradeniya.

15. *Gryllulus mitratus* (Burm.)

*Gryllus mitratus* Burmeister, 1838. *Hand. Ent.*, II, p. 734. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 509

Battaramulla, XII-1931, V-1933; Marai Villu, III-1933; Matale, IV-1933; Kandy, Peradeniya, Diyatalawa.

This species and the preceding one are both very common in the Oriental region.

16. *Gryllulus configuratus* (Walk.)

*Gryllus configuratus* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, Suppl., p. 8. Chopard, 1928. *Spol. Zeyl.* XIV, p. 198

*Gryllus quadristigatus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 510

Diyatalawa, Sigiriya, Colombo, Bintenne, Battaramulla, Murunkan, Wellawaya, June to January; Marichchukkaddi, III-1933; Galge, Uva P., IV-1933.

A species described from Bombay, very common in India.

17. *Gryllulus flavus*, sp. nov.

Type: Rakwana, 1-V-1929, 1 ♀. Allotype: Balangoda, 13-IV-1926, 1 ♂.

A medium sized species; general shape feebly depressed; coloration very uniform light fulvous brown. Head with a feebly marked pattern, formed of a narrow yellow band between the eyes and a wide, feebly visible, light band on the forehead; face yellow. Scutello-frontal suture very low, weakly inflexed.

Pronotum and legs uniformly yellowish brown, with an abundant, dark pubescence. Posterior femora rather short and thick; tibiae armed with five or six external, five internal, slender, yellow spines with brown tips; supero-internal apical spur nearly equal to the median one. Ovipositor rather long, slender, with apical valves very narrow, acute.

Elytra showing the same pale fulvous tint as the body, shining; dorsal field with somewhat oblique, almost regularly spaced veins; areolae lengthened at base and towards the internal margin, narrower on the disc and towards the apex; lateral field nearly transparent with spaced veins, six in number, of which four are free ones and two are branches of the mediastinal vein. Wings caudate.

♂: General coloration a little darker and with marking more distinct than in the female. Elytra with speculum much longer than wide, with rounded angles, non-divided; two oblique veins; chords

feebly curved, the first one very close to the diagonal; lateral field with spaced veins as in the female, three mediastinal branches; apical field rather long and narrow, with four sectors, and divided into very wide areolae.

Length of body ♀ 14 mm., ♂ 11 mm.; posterior femur ♀ 8 mm., ♂ 7 mm.; elytra ♀ 9 mm., ♂ 7 mm. ovipositor 11 mm.

This species belongs to the *burdigalensis*-group but reminds one also of the *configuratus*-group in its rather stout shape although it is less depressed than in this group. It is rather close to *confirmatus*, showing the same shape of the scutello-frontal suture; it is somewhat stouter than this last species, with narrower speculum in the male, longer and more acute ovipositor in the female. The uniformly pale fulvous coloration is very characteristic.

Besides the type and allotype, the collection contains the following specimens:

Madola near Opanake, 16-23-II-1933, 3 ♀♀; Rakwana, 3-V-1929, 2♀♀; Battaramulla, 28-I-1930, 1 ♀.

#### 18. *Gryllulus confirmatus* (Walk.)

*Acheta confirmata* Walker, 1859. *Ann. Mag. Nat. Hist.* (3) IV, p. 221. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9), XV, p. 509

Barberyn, 1d., XII-1926; Mihintale, VII-1931; Bintenne, X-1928; Battaramulla, 21-V-1931; Vilapala Wewa, XII-1931; Wellawaya, XII; Trincomalee, IV-1931; Ratnapura, IX; Colombo, Peradeniya, Eppawela.

This species has been described from Ceylon; it is common in the Indian region.

#### 19. *Gryllulus bucharicus* (Bei-Bienko)

*Gryllus bucharicus* Bei-Bienko, 1933. *Bol. Soc. Esp. Hist. Nat.*, XXXIII, p. 323, fig. 8

Marai Villu, III-1933; Bandarawela, IV-1931; Marichehukkaddi, III-1933.

These specimens agree with Bei-Bienko's description although the face is not quite so black. This author has evidenced a very good character in the shape of the suture between the facial shield and the forehead; yet I do not think that this character can be considered as generic as Bei-Bienko suggests. Besides he certainly grants too much importance to coloration which is highly variable in these *Gryllulus*.



20. *Gryllulus brevicauda*, sp. nov.

Type: Bintenne, X-1928, 1 ♀. Allotype: Kandy, 2-5-IV-1926, 1 ♂.

♀: Small; general habitus of *G. burdigalensis* with bigger and rounder head. This one is globular, shining brown; occiput with six short, yellowish lines; forehead without any markings; frontal rostrum wide; face brown; scutello-frontal suture rather low, but convex. Palpi yellowish, the three last joints of the maxillary ones nearly equal in length. Antennae brown.

Pronotum transverse, very slightly enlarged in front; anterior margin very weakly concave, posterior margin straight; disc regularly convex, dark brown, mottled with yellowish, somewhat pubescent; lateral lobes with yellow inferior part. Abdomen brown above, yellowish beneath. Ovipositor (Fig. 3) extremely short but not rudimentary; its shape being as usual in most of the *Gryllulus* with lanceolate apical valves.

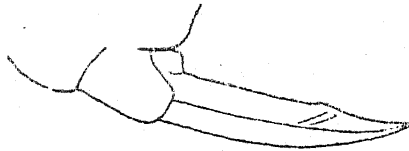


Fig. 3. *Gryllulus brevicauda*, sp. nov., ovipositor

Legs lighter than the body, yellowish. Anterior tibiae perforated, at external face only, with a large, oval tympanum. Posterior femora thick and rather short; tibiae armed with five external, four internal spines; supero- and medio-internal spurs subequal in length.

Elytra short, extending no farther than the 3rd abdominal tergite, rounded at apex; dorsal field dark brown, shining, with four slightly oblique veins, the 4th furcate near the base; transverse veinlets scarce, rather irregular; lateral field brown, presenting four rather close veins. Wings abortive.

♂: Similar to the female, but a little lighter, with a feebly visible, incomplete brown band between the ocelli; head somewhat bigger. Posterior femora bearing five spines on each margin. Elytra extending nearly to the apex of abdomen, rounded at apex; speculum as long as wide, with much rounded angles, non-divided; diagonal vein long, nearly straight; chords regularly curved without any connexion with

the mirror; three oblique veins, almost straight and parallel; lateral field with four regularly spaced veins and two branches of the mediantal. No wings.

Length of body 12 mm.; posterior femur 8 mm.; elytra ♀ 4 mm., ♂ 6 mm.; ovipositor 1.6 mm.

This species is very remarkable by the extreme shortness of the ovipositor, the shape of which reminds one of the *Brachytrypites*; apart from this feature the insect does not differ conspicuously from the *Gryllulus* of the *burdigalensis*-group, except for the bigger head. One macropterous specimen shows a small tympanum on internal face of the anterior tibiae.

Besides the types, the following examples are to be found in the collection:

Wellawaya, I-1928, 1 micropterous ♀; Battaramulla, XI-1929, 1 micropterous ♀; Balangoda, IV-1926, 1 micropterous ♀; Colombo, 5-IX-1920, 1 macropterous ♀.

## 21. *Gryllulus blennus* (Sauss.)

*Gryllodes blennus* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 215

*Gryllus flavipes* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 197, fig. 1-2

Colombo, II-1933; Battaramulla, I-1933; Marai Villu, III-1933; Madola near Opanake, II-1933; Bandarawela, IV-1931.

Having compared examples of *G. blennus* from Java with the species I had named *flavipes*, I feel convinced that it is the same insect which ranges from India to the Sunda Islands. The posterior femora are sometimes entirely rufous and not darkened at apex.

## 22. *Gryllulus pallipes* (Chop.)

*Gryllus pallipes* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 510, fig. 3

Peradeniya.

This species is very close to the preceding one; it differs from it in the characters given in the table of the species.

## Genus *Gryllodes* Sauss. 1874

The genus *Gryllodes* is here restricted to very few species which have the general aspect of true *Gryllulus* but with narrower frontal rostrum.

## KEY TO THE SPECIES

- Elytra of male truncated with almost no apical field; those of the female lateral, lobiform . . . . . *sigillatus*
- Elytra well developed in both sexes; wings caudate . . . . . *supplicans*

23. *Gryllodes sigillatus* (Walk.)

*Gryllus sigillatus* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 45. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 511

Bibile, VII-1929; Wellawaya, I-1928; Battaramulla, II-1930; Batticaloa, Galle.

This species is rather common and cosmopolitan in the tropical and subtropical regions. It often lives inside human dwellings.

24. *Gryllodes supplicans* (Walk.)

*Acheta supplicans* Walker, 1859. *Ann. Mag. Nat. Hist.* (3) IV, p. 221  
*Gryllus supplicans* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 510  
*Gryllodes supplicans* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 199  
*Gryllodes greeni* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 511, fig. 5

Matale, IV-1931; Bandarawela, IV-1931.

This species was described from Ceylon; it has exactly the shape and the colour pattern of the preceding one. Yet it seems quite impossible to consider it as a mere macropterous form of *sigillatus*. Effectively, in the female of the latter species, the elytra are reduced to very small, lateral lobes, and it is quite unusual to find such a difference between the macropterous and the micropterous forms of a single species.

Genus *Gryllopsis* Chop. 1928

This genus contains a certain number of species in India, one of which only has been recorded by Kirby from Ceylon, without any exact locality; this record therefore requires verification.

25. *Gryllopsis falconneti* (Sauss.)

*Gryllodes falconneti* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 230. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 511

Recorded by W. F. Kirby.

Genus **Nemobiodes** Chop. 191826. **Nemobiodes laeviceps** Chop.

*Nemobiodes laeviceps* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 513

*Nemobiodes ceylonicus* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 199, fig. 3-4

Urugalla.

27. **Nemobiodes nigrocephalus** Chop.

*Nemobiodes nigrocephalus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 514, fig. 6

Hakgala, VIII-1929; Binteane, X-1928; Mousakande, Gammaduwa, XI-1929; Matale, XII-1928.

This species is very close to the preceding one and chiefly differs in the smaller size. The differences in the elytral venation are very slight and rather individual than specific; it may be merely a small variety of *laeviceps*.

Genus **Cophogryllus** Sauss. 187728. **Cophogryllus martini** Bol.

*Cophogryllus martini* Bolivar, 1900. *Ann. Soc. Ent. Fr.*, LXVIII, p. 798.

Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 515, fig. 7

Sigiriya.

This small species is known from South India and Ceylon only.

Genus **Scapsipedus** Sauss. 1877

## KEY TO THE SPECIES

- Larger (14-18 mm.); face of male with very long, prominent mandibles; elytra of female usually extending to the apex of abdomen . . . . . *aspersus*
- Smaller (12 mm.); mandibles of male without any special conformation; elytra of female much shorter than the abdomen . . . . . *ceylonicus*

29. **Scapsipedus aspersus** (Walk.)

*Gryllus aspersus* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 39 (♀)

*Grylloides berthellus* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 205 (♀)

*Gryllus berthellus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 510

*Scapsipedus mandibularis* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 246 (♂).

Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 515

Battaramulla, V-1932; Colombo, VIII-1932; Peradeniya.

This species is common and widely distributed in the Oriental region.

30. **Scapsipedus ceylonicus** Chop.

*Scapsipedus ceylonicus* Chopard, 1928. *Rec. Ind. Mus.*, XXX, p. 18

Battaramulla, I-1932; Colombo, VIII-1932; Balangoda, IV-1926.

This small species is very close to *S. parvus* Chop., from Darjeeling; it seems that a good difference with that species can be found in the elytral venation of the male in which the distance between the mirror and the chords is much smaller; the ovipositor is rather short and blunt at apex.

Genus **Coiblemmus**, gen. nov.

This new genus is close to *Scapsipedus* and *Homaloblemmus*, presenting, as in those two genera, a much flattened, even concave, face; the frontal rostrum is very wide between the antennae, somewhat prominent, with rounded angles, forming a slight protuberance, the apex of which is depressed in the shape of a small soft cupule which is probably turgescient in life. The shape of the frontal rostrum is quite different from that of the male of the typical species of the genus *Homaloblemmus* (*H. zambesi* Sauss.), which I have recently had opportunity to study, and this difference needs the creation of the present new genus.

Genotype; *Homaloblemmus compactus* Chop.

31. **Coiblemmus compactus** (Chop.)

*Homaloblemmus compactus* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 201, fig. 5 6

*Homaloblemmus cavifrons* Chopard, 1933. *Stylops*, II, p. 116, fig. 3

Yala, II-1933; Wellawaya, IV-1931; Marichehukkaddi, III-1933; Mihintale, VII-1927; Elephant Pass, I-1923; Vavuniya, XII-1923.

After comparison of specimens from India and from Ceylon, I have become assured that all of them belong to the same species. In the small males, the head is relatively smaller, the forehead less concave and the frontal protuberance a little less projecting but showing the same general shape.

Genus **Loxoblemmus** Sauss. 1877

The males of the species of the genus *Loxoblemmus* are easy to recognize by the shape of the head, the face being strongly flattened

and the forehead forming a protuberance which is rather strongly projecting between the antennae; in the females, the head is more similar to that of *Gryllulus* but the face is nevertheless feebly flattened.

## KEY TO THE SPECIES

- |  |       |                    |
|--|-------|--------------------|
| Larger (18 mm.); process of forehead rather projecting, feebly angulate in the male; labial palpi very long              | ..... | <i>longipalpis</i> |
| Smaller (12 mm.); process of forehead very slightly projecting, nearly rounded in the male; labial palpi moderately long | ..... | <i>equestris</i>   |

32. *Loxoblemmus equestris* Sauss.

*Loxoblemmus equestris* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 252, pl. 13 (XVI), fig 4, 4 a-c. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 515

Rakwana; Hanwella; Bintenne; Mousakande, Gammaduwa; Battaramulla; Peradeniya; October to May.

A common and widely distributed species in Southern Asia.

33. *Loxoblemmus longipalpis* Chop.

*Loxoblemmus longipalpis* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 200

Madola near Opanake, II-1933; Colombo, X-1919.

This species is easy to distinguish from the preceding one in its much larger size and, in the male, by the very long labial palpi. In the female, the palpi are normal and the general shape is very similar to that of *L. detectus* Serv. but the veins of lateral field of the elytra are a little more regular.

Genus *Stephoblemmus* Sauss. 187734. *Stephoblemmus humbertiellus* Sauss.

*Stephoblemmus humbertiellus* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 260, pl. 13 (XVII), fig. 1-3. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 515

Alutnuwara, X-1928, 1 ♂.

This is a very characteristic species which must be rather scarce, as the specimen here recorded is the first one found since Saussure's description; the female is unknown.

Genus **Scapsipedoides**, gen. nov.

A genus close to *Scapsipedus*, showing the same shape of the head, but completely apterous, with non-perforated anterior tibiae. This genus shows the same deformation of the head in relation to *Cophogryllus* as *Scapsipedus* does to *Gryllus*.

Genotype: *Scapsipedoides macrocephalus*, sp. nov.

35. **Scapsipedoides macrocephalus**, sp. nov. (Fig. 4)

Type: Belihuloya, 1-IX-1928, 1 ♂.

A rather large species; dark chestnut brown. Head very big; occiput and forehead convex, without any ornament; face very strongly excavated; mandibles long and strong; cheeks strongly ridged and presenting beneath the eye a deep depression which is prolonged backwards. Palpi yellowish, rather long, the 5th joint of maxillary ones much longer than the 4th. Antennae brown. Eyes little projecting, feebly lengthened; ocelli big, yellow, disposed as a triangle.

Pronotum transverse, strongly widening in front; anterior and posterior margins feebly convex; disc chestnut brown, covered with a whitish pubescence, the usual pyriform impressions rufous; lateral lobes widely yellowish in front, with inferior margin slightly ascending backwards. Abdomen brown, cylindrical, a little pubescent. Genitalia presenting a titillator lengthily furcate at apex.

Legs a little lighter than the body, rather long; anterior tibiae non-perforated. Posterior femora thick, slightly striated at their external face; tibiae with five spines on each margin; supero-internal apical spur a little shorter than the median one; metatarsi compressed, armed with seven to eight denticles on each margin.

Length of body 20 mm.; pronotum 4.2 mm.; posterior femur 14.5 mm.; posterior tibia 10 mm.

Another male of the same species, from Trincomalee, is immature and presents neither the deformation of the face nor the deep depression beneath the eyes observed in the type specimen.

36. **Scapsipedoides apterus**, sp. nov.

Type: Madola near Opanake, 16-23-II-1933, 1 ♂.

Much smaller than the preceding one; very dark brown. Head moderately big; occiput and forehead of a nearly black brown, without

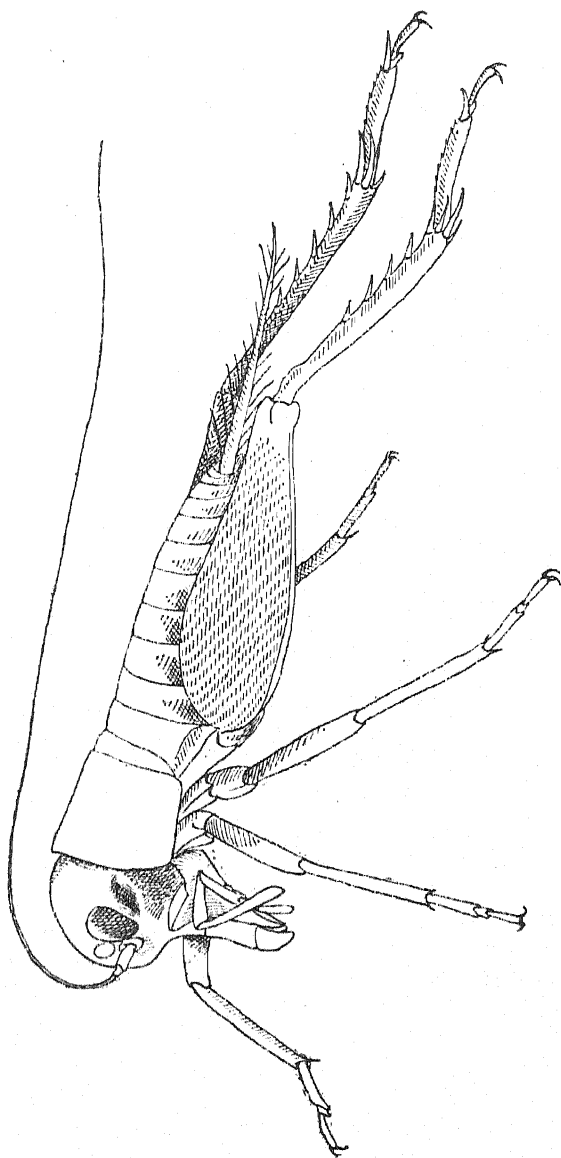


Fig. 4. *Scapsipediodes macrocephalus*, sp. nov.



any markings; face rufous yellow, merely flattened, not excavated; mandibles long, but not so developed as in the preceding species; cheeks shagreened beneath the eyes but not depressed. Palpi yellowish.

Pronotum transverse, feebly widening in front; anterior margin straight, posterior one slightly convex; disc convex, brown with a whitish pubescence, the usual impressions tinged with rufous; lateral lobes widely yellowish in front. Abdomen nearly cylindrical, dark brown, pubescent. Genitalia bifid as in the preceding species.

Legs light rufous, pubescent; anterior tibiae non-perforated; posterior tibiae armed with five spines on each margin; supero-internal apical spur a little shorter than the median one.

Length of body 14 mm.; pronotum 4 mm.; posterior femur 11 mm.; posterior tibia 8.5 mm.

This species differs from the preceding one in the shape of the head, but it is so closely related to it in its general characters that it might almost be considered as a variety minor of *S. macrocephalus*.

#### Genus *Landreva* Walk. 1869

A series begins with this genus which is rather different from the other genera of Gryllinae as their posterior tibiae are serrulated at base before the first spine. This character leads to the Phalangopsinae with which the species of the group have also a general superficial likeness.

#### KEY TO THE SPECIES

1. Posterior tibiae with internal margin unarmed before the spines . . . . . *subaptera*
- Posterior tibiae armed on both margins before the spines . . . . . 2
2. Frontal rostrum as wide as the first antennal joint, with parallel margins . . . . . *clara*
- Frontal rostrum narrower than the first antennal joint, with slightly converging margins . . . . . 3
3. Frontal rostrum flat; speculum in the male elytra extremely long, scarcely distinct from the apical reticulation . . . . . *insignis*
- Frontal rostrum a little convex above; speculum of the male well separated from the apical reticulation . . . . . *angustifrons*

**37. *Landreva clara* (Walk.)**

*Gryllus clara* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I. p. 39 (♀)

*Landreva clara* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 516, figs. 8-10

Battaramulla, XII-1929, VII-1930; Labugama, I-1930; Haldummulla, VI-1926; Balangoda, IV-1926; Bibile, VII-1929; Marai Villu, III-1933; Hakgala, VIII-1929; Peradeniya, Galle.

Known from Ceylon only.

**38. *Landreva subaptera* Chop.**

*Landreva subaptera* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 517, fig. 11

Namunakula, XI-1910 (type).

This species, which is known from the type specimen only, is easy to distinguish from the preceding one by its more slender general shape and by the more feebly armed posterior tibiae.

**39. *Landreva insignis* Walk.**

*Landreva insignis* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I. p. 55

Maskeliya, VI-1915; Labugama, VIII-1932; Morningside, Rakwana (4,000 ft.), V-1929.

This species is close to *L. clara* but differs from it in the narrower frontal rostrum, the shape of the elytral mirror in the male, the longer elytra in the female. Walker's description requires a few more details.

♂: Rufous brown, shining. Head a little wider than the pronotum in front; occiput convex, presenting tracks of narrow, brown lines; frontal rostrum narrow, with slightly converging, feebly keeled margins; posterior ocelli united by a small oblique keel; anterior ocellus in the bottom of a small furrow. Face short, brown, shining. Maxillary palpi with 5th joint short, securiform.

Pronotum a little wider than long, with anterior margin concave, posterior one a little convex, somewhat narrowing in front and backwards; disc rufous, a little flattened, with pyriform impressions lighter and placed very much forwards; lateral lobes concolorous, with inferior margin strongly ascending backwards. Abdomen shining brown, feebly pubescent; 10th tergite truncated, with two small rounded impressions near the median line; subgenital plate nearly triangular.

Legs short and strong, a little lighter than the body. Anterior tibiae perforated with a large external tympanum. Posterior tibiae armed with four spines on each margin and with three to four denticles at base of internal margin, about ten on external one; apical spurs as in *L. clara*.

Elytra extending to the apex of 4th abdominal tergite, rounded at apex; speculum nearly apical, very narrow and lengthened; diagonal vein long, sinuated, coming almost to the external angle of the mirror; apical field very short, presenting only a few large, badly defined cells; chords a little diverging, the 1st one united to the internal angle of the mirror by a veinlet; anal vein very strongly sinuated; six oblique veins, the two first long, arising from the base of the anal vein; lateral field with five close veins, sinuated towards the apex, and three branches of the mediastinal vein.

♀: Similar to the male. Abdomen a little pubescent with a faint median brown band. Ovipositor rather long, slender, with small, acute, lanceolate apical valves. Elytra very widely separated on the median line, no longer than the metanotum, their internal margin very oblique; dorsal field rufous brown with a yellowish spot at base, presenting five parallel veins, united by numerous transverse veinlets; lateral field with three much curved veins and the mediastinal vein which is not furcate.

Length of body ♂ 21-23 mm., ♀ 20-26 mm.; elytra ♂ 7.5-8.5 mm., ♀ 3-3.5 mm.; ovipositor 14-18 mm.

#### 40. *Landreva angustifrons*, sp. nov. (Fig. 5)

Type: Labugama, 15-18, VIII-1932, 1♂. Allotype: Mousakande, Gammaduwa, 12-IV-1932, 1♀.

Very close to the preceding species; frontal rostrum narrow, but convex above; no small keel between the lateral ocelli; last joint of the maxillary palpi a little longer, triangular. Posterior tibiae presenting at base six internal, eight external denticles. Elytra with a venation comparable to that of *insignis*, but with a well defined mirror in the shape of a lengthened oval, twice as wide as long; diagonal vein coming about the middle of the anterior margin of the mirror; lateral field with five close nearly straight veins, the mediastinal one bearing one branch.

♀: Head as in male. Elytra a little narrower than in *insignis*, their dorsal field presenting three veins only. Ovipositor long and slender.

Length of body ♂ 21 mm., ♀ 20 mm.; posterior femur ♂ 14.5 mm., ♀ 13.5 mm.; elytra ♂ 9 mm., ♀ 2.5 mm.; ovipositor 16 mm.

This species shows, like *L. insignis*, a narrow frontal rostrum, but this is convex and not flat above; the elytral speculum of the male is rather like that of *L. clara*; the female is very close to *insignis* but with still narrower elytra.

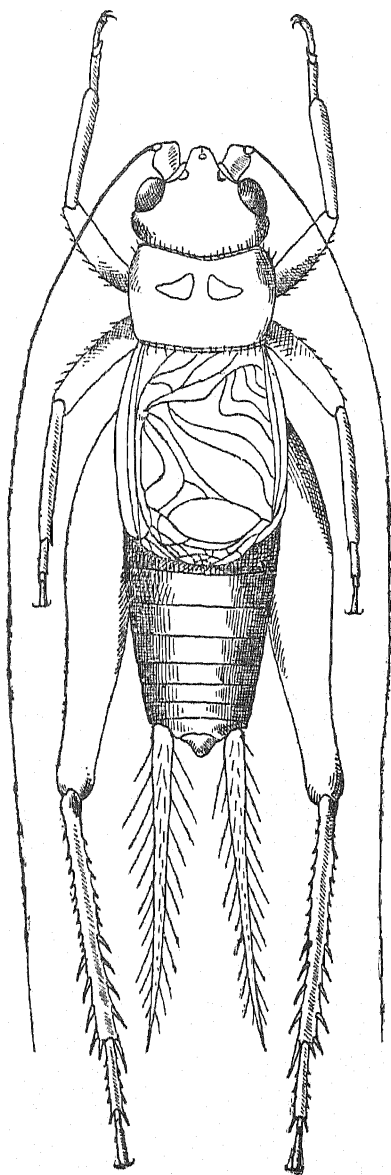


Fig. 5. *Landreva angustifrons*, sp. nov.

A second male, also from Labugama, is a little smaller (17 mm.) and presents a narrower elytral mirror which is also more acute on each side.

Genus **Hemilandreva**, gen. nov.

Close to *Landreva*, but differing in the male elytra which are very short, triangular, with a confused venation, presenting no distinct mirror.

Genotype: *Hemilandreva lamellipennis*, sp. nov.

41. **Hemilandreva lamellipennis**, sp. nov. (Fig. 6)

Type: Nonpareil Estate, Belihul-oya (4,000 ft.), 3-IX-1928, 1 ♂; Paratype: Maha-oya, 25-VII-1929, 1 ♂.

Size medium; coloration rufous, varied with yellowish and brown, provided with a tenuous yellowish pubescence. Head as wide as the pronotum in front; frontal rostrum as wide as the first antennal joint, with slightly converging margins, flat above, neither convex nor hollowed; face very short and wide, brown; cheeks and base of the mandibles a little ridged. Palpi short, yellowish; 4th joint of maxillary ones shorter than 3rd, 5th short, securiform. Antennae rufous with large, slightly depressed 1st joint. Eyes rather strongly projecting forwards, lengthened; ocelli very small, the anterior one nearly at extremity of the rostrum.

Pronotum a little wider than long, with anterior margin slightly concave, posterior margin straight, sides feebly converging forwards and backwards; disc a little convex, brownish, pubescent, with the pyriform impressions lighter, and two small oblique tuberculiform protuberances near the posterior margin; lateral lobes brown with yellowish anterior angle, inferior margin strongly ascending backwards. Abdomen rufous brown, pubescent, with a large, smooth region beginning in a point on the 2nd tergite and widening towards the apex; the 4th, 5th, and 6th tergites bear a tuft of long, yellow hairs near the middle; 10th tergite rufous, with strongly projecting angles; supero-anal valve rounded; subgenital plate narrowing and slightly notched at apex.

Legs short, pubescent, lighter than the body, a little mottled with brown. Anterior tibiae perforated, at external face only, with a small, almost round tympanum; tarsi rather short, the 3rd joint equalling the other two united. Posterior femora short and thick; tibiae armed with four spines and four or five basal denticles on each margin;

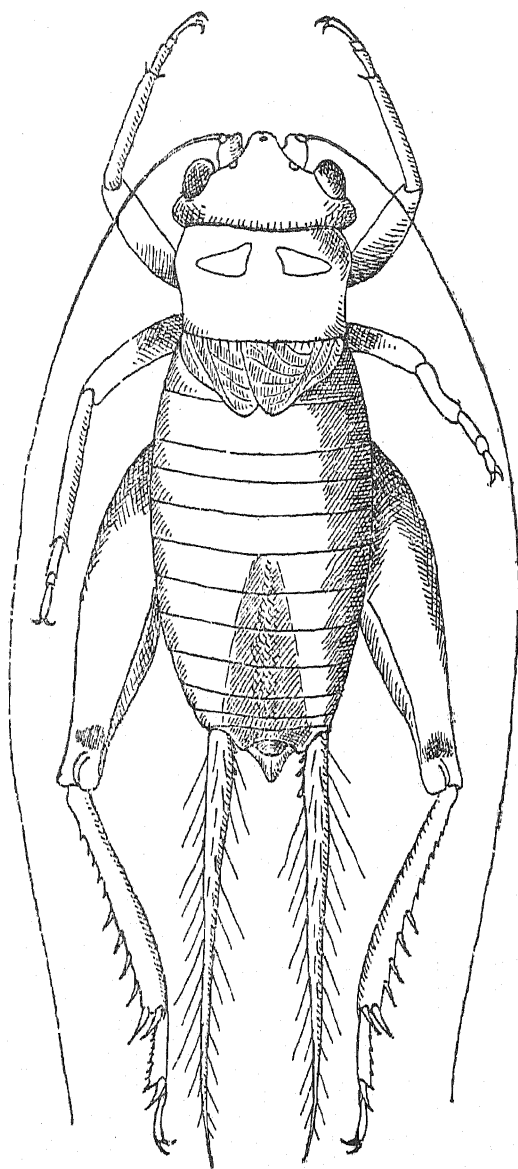


Fig. 6. *Hemilandrevia lamellipennis*, sp. nov.

external apical spurs short, the median one a little longer than the other two; infero-internal spur very short, the other two moderately long, thick, subequal in length; metatarsi rather thick, armed with four or five denticles on each margin.

Elytra very short, not exceeding the metanotum, but widely crossing on the median line; dorsal field flat, thickened, forming a triangular lamella, with rounded apex; neuration quite confused, comprising only three or four weak, more or less anastomosed veins; lateral field merely represented by a small lobe, much shorter than the dorsal field, presenting two small veins.

Length of body 17 mm.; pronotum 3.5 mm.; posterior femur 10.5 mm.; posterior tibia 6 mm.; elytra 2 mm.

This is a very remarkable species in the shape of the elytra which are completely dorsal, the lateral field being almost null, placed on the same level as the dorsal field which forms a thick, horizontal lamella.

#### Sub-family NEMOBIINAE

The Nemobiinae are small Gryllids which live on the ground under dead leaves and are very hygrophilous; they are often found in the neighbourhood of streams or ponds and some species willingly enter water. The posterior tibiae are armed with long, movable, hairy spines which are characteristic of the group.

#### KEY TO THE GENERA

- |   |       |                      |
|---|-------|----------------------|
| 1. Apterous in both sexes; anterior tibiae non-perforated           | ..... | <i>Scottia</i>       |
| — Both sexes provided with elytra                                   | ..... | 2                    |
| 2. Legs very long; elytra of the male devoid of a tympanum          | ..... | <i>Paranemobius</i>  |
| — Legs moderately long; elytra of the male provided with a tympanum | ..... | <i>Pteronemobius</i> |

#### Genus *Paranemobius* Sauss. 1877

This genus shows a very special habitus chiefly due to the length of the posterior legs, the femora of which are very much attenuated in their apical part. Two species only of *Paranemobius* are known, one of which exists in Ceylon.

42. *Paranemobius pictus* Sauss.

*Paranemobius pictus* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 67, pl. 11 (VI), figs. 1-3. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 506

Labugama, III-1931; Belihul-o-ya, VII-VIII-1928; Kitulgala, II-1928; Ratnapura, XII-1921; Kallar, VIII-1930; Peradeniya.

This species is usually wingless; yet very scarce macropterous specimens are to be found with the typical form.

Genus *Pteronemobius* Jak. 1904

## KEY TO THE SPECIES

1. Posterior femora adorned with blackish bands ..... 2
- Posterior femora unicolorous ..... 3
2. Maxillary palpi very dark at base, with 4th and 5th joints nearly black; lateral lobes of pronotum blackish; dark bands of posterior femora wider than the light parts ..... *fascipes*
- Maxillary palpi testaceous, a little darkened at apex; lateral lobes of pronotum for the most part rufo-testaceous; blackish bands of posterior femora narrower than the light parts ..... *csikii*
3. Lateral lobes of pronotum and lateral field of elytra blackish, contrasting with the upper part which is of a testaceous greyish tint ..... *taprobanensis*
- Lateral lobes of pronotum and lateral field of elytra of the same colour as the upper part ..... 4
4. Elytra relatively short and wings very long; head and pronotum chestnut brown, elytra yellowish ..... *bicolor*
- Elytra extending to the apex of abdomen; wings relatively shorter; coloration uniformly brownish ..... 5
5. Size larger (7-8 mm.); ovipositor longer (5 mm.) and straighter ..... *vagus*
- Size smaller (5-7 mm.); ovipositor shorter (2.5-3 mm.), gently curved ..... 6
6. Size smaller (5-6 mm.); coloration light testaceous ..... *concolor*
- Size a little larger (6.5-7 mm.); coloration darker ..... *birmanus*



43. ***Pteronemobius concolor* (Walk.)**

*Eneoptera concolor* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, suppl., p. 10

*Nemobius tartarus* Saussure, 1874. *Fedchenko Reiste Turkestan, Orih.*, p. 36, pl. 1, fig. 15

*Nemobius ceylonicus* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 86

*Pteronemobius gravelyi* Chopard, 1924. *Rec. Ind. Mus.*, XXVI, p. 183

*Pteronemobius heydeni tartarus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 507

*Pteronemobius heydeni ceylonicus* Chopard, 1925. *Loc. cit.*, p. 507

Colombo, at light, X-1927; Trincomalee, IV-1931; Marichehuk-kaddi, III-1933; Marai Villu, III-1933; Madola near Opanake, II-1933; Ratnapura, IX-1929; Negombo, I-1929; Battaramulla, X-1929, I-III-1930; Yatiyantota; Matale.

This Gryllid seems to be an oriental subspecies of the European *Pteronemobius heydeni* of which *P. tartarus* is simply the macropterous form. *P. concolor* differs slightly from it in being smaller and of a very uniform light testaceous brown coloration. The mirror of the male elytron is almost always of the most characteristic first type of Saussure, presenting two large, nearly equal cells, the internal one not extending to the angle of the mirror; yet rather frequent variations are to be found in the venation to which it is impossible to grant such an importance as Saussure used to do.

*Pteronemobius concolor* is almost always a macropterous insect; the micropterous form, which is scarce, seems to be identical with Saussure's *Nemobius ceylonicus*; one individual only, from Ratnapura, belongs to this form.

44. ***Pteronemobius birmanus* Chop.**

*Pteronemobius birmanus* Chopard, 1918. *Ann. Soc. Ent. Fr.*, 1917, LXXXVI, p. 556, fig. 84

Colombo, VIII-1930; Battaramulla, I-1930.

This species is quite intermediate between *concolor* and *vagus*. It attains almost to the size of the latter but the characters of the male genitalia and of the ovipositor are rather those of *concolor*. The genitalia (Fig. 7 d) show feebly acute hooks as in *concolor* but equal in length those of *vagus*; the ovipositor is short and gently curved. The female, which has not been described, shows an elytral venation quite comparable to that of *vagus*, i.e., three veins in the dorsal field, the 3rd of which is furcate near the apex. The coloration

of the Ceylonese individuals is rather dark with a yellowish elytral edge.

Length of body 6.5 mm.; ovipositor 3 mm.

#### 45. *Pteronemobius vagus* (Walk.)

*Nemobius vagus* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, suppl., p. 10. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 507

Battaramulla, IX-1927, I-1930; Balangoda, IV-1926; Barbery Id., XII-1926; Colombo, XII-1926; Peradeniya.

Although very close to *P. concolor*, this species is easy to distinguish by its much larger size; the armature of the posterior tibiae and the elytral venation in the male are quite similar in both species, but the ovipositor is quite different, much longer and straighter in *vagus*. The genitalia, although belonging to the same type, are rather different; in both species, they form a sort of forceps with double branches, but these branches are much more slender in *vagus* than in the different races of *concolor* (Fig. 7).

*Pteronemobius vagus* seems much less common than *concolor* in Ceylon; it is widely spread in tropical Asia: India, Burma, Indo-China, Sumatra.

#### 46. *Pteronemobius taprobanensis* (Walk.)

*Trigonidium taprobanense* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 102 (macropterous ♀)

*Eneoptera lateralis* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V., suppl., p. 11 (macropterous ♂ and ♀)

*Nemobius javanus* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 85 (macropterous ♂ and ♀)

*Nemobius infernalis* Saussure, 1877. *Loc. cit.*, p. 83 (micropterous ♀)

*Pteronemobius taprobanensis* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 507

*Pteronemobius taprobanensis infernalis* Chopard, 1925. *Loc. cit.*, p. 507

Colombo, V-VII-1929; Bandarawela, IV-1931; Ratnapura, IX-1929; Labugama, I-1930; Battaramulla, X-1929, I-III-1930; VI-1931; Arugam Bay, IV-1931; Peradeniya, Hakgala, Trincomalee.

This species is easy to recognize by its coloration which is greyish testaceous above, dark brown on the sides; the macropterous form seems more scarce than the micropterous one but is found with it. The species is widely spread in India, Indo-China, Burma, Sumatra, Phillippines, Japan (*Nemobius mikado* Shiraki). It was described from Ceylon.

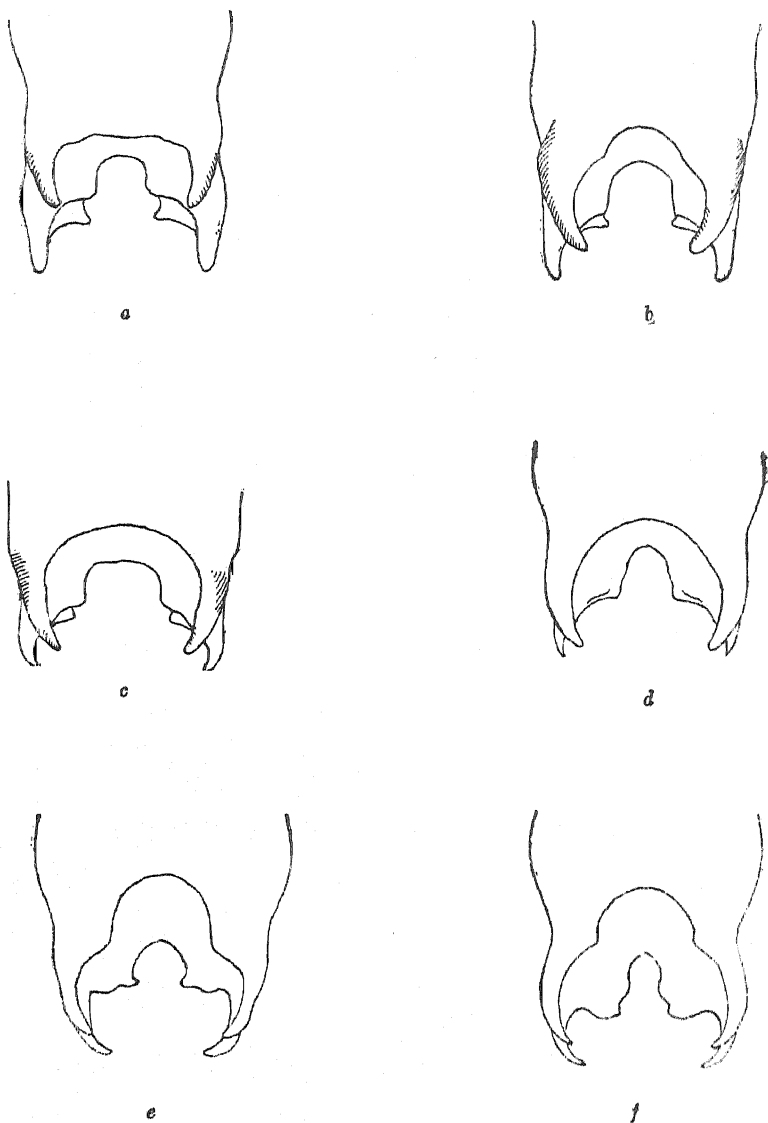


Fig. 7. Apex of genitalia of :

- a *Pteronemobius concolor* Walk. (from Transcaucasia)
- b *P. heydeni* Fisch.
- c *P. concolor* Walk. (from Ceylon)
- d *P. birmanus* Chop.
- e *P. vagus* Walk. (from Ceylon)
- f *P. vagus* Walk. (from Sumatra)

47. *Pteronemobius fascipes* (Walk.)

*Eneoptera fascipes* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 67 (macropterous ♂)

*Eneoptera alboatra* Walker, 1871. *Loc. cit.*, V, suppl., p. 11 (micropterous ♂ and ♀)

*Nemobius histrio* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 95 (micropterous ♂)

*Nemobius nigrosignatus* Brunner, 1893. *Ann. Mus. Genova*, XXXIII, p. 196, fig. 67, pl. 6

*Pteronemobius alboater* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 507

A very distinct species which presents the same geographical distribution as the preceding one. As in this last species the micropterous form seems more common than the macropterous one.

48. *Pteronemobius csikii* (Bol.)

*Nemobius csikii* Bolivar, 1901. *Zichy Zool. Ergebn.*, II, p. 248

*Pteronemobius csikii* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 507

Colombo, X-1926; VIII-1931; Trincomalee, Peradeniya.

Although rather close to the preceding, this species is easy to distinguish. It seems also widely spread but much more scarce than *fascipes*.

49. *Pteronemobius bicolor* (Sauss.)

*Nemobius bicolor* Saussure, 1877. *Mém. Soc. Genève*, XXV, p. 98, pl. 11 (VII), figs. 5-6

Marai Villu, III-1933.

This species belongs to a very special type and is related to *P. gracilis* Jak. from the desert parts of North Africa and Western Asia; it was previously known from India only.

Genus *Scottia* Bol. 191250. *Scottia ceylonica*, sp. nov. (Fig. 8)

Type: Newera Eliya, 8-IV-1931, 1 ♀.

Very small, rufous brown. Head as wide as pronotum in front, a little shining, without any ornament; forehead with two rows of long bristles; frontal rostrum narrow; face rufous. Eyes rounded, feebly projecting; ocelli very small. Palpi brownish; 4th joint of the maxillary ones much shorter than 3rd, 5th rather large, triangular. Antennae brownish.

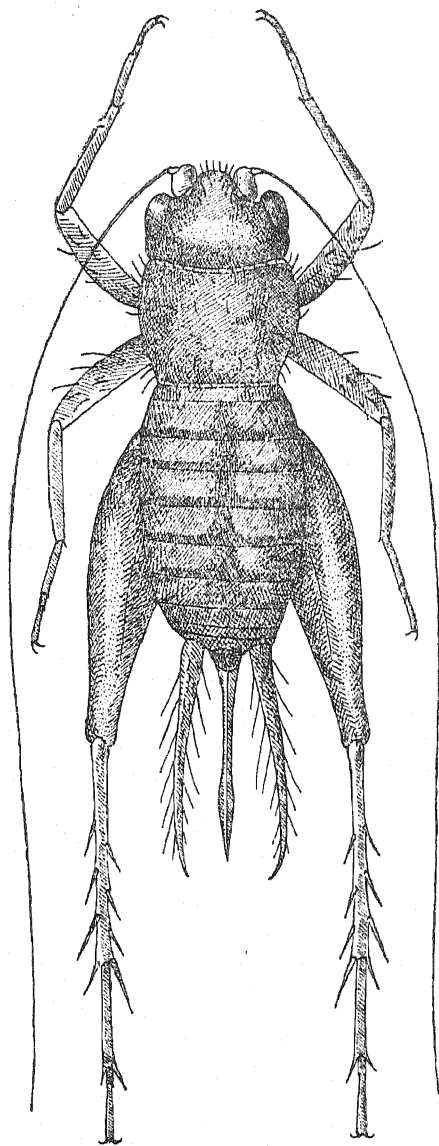


Fig. 8. *Scottia ceylonica*, sp. nov.

Pronotum transverse with anterior and posterior margins straight, rather strongly constricted backwards; disc convex, a little shining, provided with long bristles; lateral lobes concolorous with inferior margin very slightly ascending backwards. Abdomen rufous brown with tergites a little darkened along the posterior margin, bearing a fine, rather abundant pubescence. Subgenital plate small, slightly notched at apex. Ovipositor rather long, straight, with apical valves narrow, lanceolate, with smooth margins, the superior margin of the superior valves slightly concave.

Legs a little lighter than the body. Anterior tibiae non-perforated. Posterior femora rather thick, unicolorous; posterior tibiae armed with three spines on each margin; six apical spurs, the inferior ones somewhat unequal in length, supero-internal longer than the median one; supero-external straight, longer than the inferior, median one much the longer, straight, feebly curved at apex.

Length of body 5.5 mm.; posterior femur 3.8 mm.; ovipositor 4 mm.

Besides the type, the collection contains the following specimens:

Mousakande, Gammaduwa, 5-XI-1929, 2 ♀; Hakgala, VIII-1929, 1 ♀.

This small species looks rather like the typical species of the genus, *Scottia chagosensis* Bol., but the latter bears a tympanum at external face of the anterior tibiae, and the posterior tibiae are armed with two internal spines only. These characters are usually of generic importance and it may prove that the species now placed in the genus *Scottia* belong to different genera; a better knowledge of these species, and especially of the males, would be necessary to decide this question.

The individuals from Mousakande have a rather shorter ovipositor but they do not seem separable specifically from the type.

#### Sub-family TRIGONIDIINAE

This sub-family includes small species of Gryllids which are not unlike the *Nemobiinae*, but they live on shrubs whereas the former are quite terrestrial in habits.

#### KEY TO THE GENERA

1. Elytral venation similar or almost similar in both sexes . . . . . 2
- Elytral venation quite different in both sexes, the male always showing a very neat anal field and a mirror . . . . . 6

2. Elytra presenting false veins between the principal veins which make them appear finely striated . . . . . *Trigonidium*
- Elytra without false veins between the principal veins . . . . . 3
3. Elytral venation rather different in both sexes . . . . . 4
- Elytral venation similar in both sexes . . . . . 5
4. Elytra of male showing a large cell forming a first essay of the mirror but no anal field . . . . . *Amusurgus*
- Elytra of male without distinct mirror but with anal field and oblique vein easily recognized . . . . . *Trigonidomorpha*
5. Veins of elytra oblique; wings much longer than elytra . . . . . *Metioche*
- Veins of elytra quite parallel; wings feebly exceeding elytra, 5th joint of maxillary palpi very short . . . . . *Metiochodes*
6. Pronotum narrowing and rounded in front; elytra presenting in the female false veins between the principal veins . . . . . *Homoeoxipha*
- Pronotum with anterior margin slightly convex, but neither rounded nor strongly narrowing . . . . . 7
7. Elytra of male with large, rhomboidal mirror; oblique vein ending on the discoidal . . . . . *Anaxipha*
- Elytra of male with small mirror; oblique vein ending in the anterior angle of the mirror . . . . . *Paranaxipha*

### Genus *Trigonidium* Ramb. 1839

#### 51. *Trigonidium cicindeloides* Ramb.

*Trigonidium cicindeloides* Rambur, 1839. *Faune Andal.*, II, p. 39. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 525

Mousakande, Gammaduwa, IV-1932.

#### 52. *Trigonidium humbertianum* (Sauss.)

*Homoeoxiphus humbertianus* Saussure, 1878. *Mém. Soc. Genève*, XXV, p. 463, pl. 17 (XLVIII), fig. 1

*Trigonidium humbertianum* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 525

Kalkudah, IV-1931.

As I previously stated, this form is probably simply a macropterous condition of the preceding one; it was described from Ceylon but is rather widely spread in the Oriental region.

Genus *Metioche* Stal. 187753. *Metioche unicolor* Chop.

*Metioche unicolor* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 526, fig. 22

Colombo, XI-1929; Peradeniya, XII-1910 (type).

As I stated in the description, the venation of this species is somewhat intermediate between the genus *Metioche* and *Amusurgus*; it looks very much like *Amusurgus oedemeroides* but differs from it in the presence of a row of small setigerous spots along the posterior margin of the pronotum.

Genus *Metiochodes* Chop. 193154. *Metiochodes greeni* (Chop.)

*Cyrtosiphia greeni* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 532, fig. 26

Arugam Bay, IV-1931; Labugama, VI-1932; Galge, V-1933; Peradeniya, VI-1910 (type).

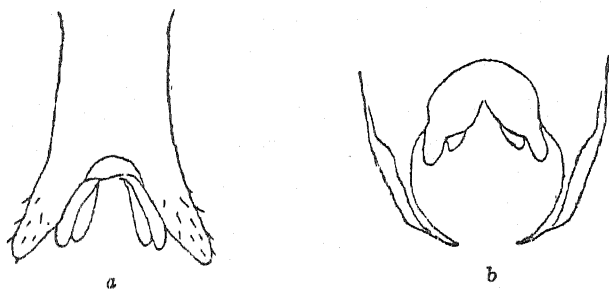


Fig. 9. Apex of genitalia a *Metiochodes greeni* Chop. b *M. flavescens* Chop.

When I described this species I only knew the female sex and I thought I had to deal with a *Cyrtosiphia* on account of the very short last joint of maxillary palpi. But I found later that the male is exactly similar to the female, presenting no trace of a mirror. The species is therefore extremely close to *Metiochodes flavescens* Chop., from Sumatra, but it differs from it in the pronotum being much wider in front, which makes the head appear less wide; besides the genitalia are quite different in the males of both species; very small in *greeni*, they are larger and more strongly curved in *flavescens* (Fig. 9 a, b).



55. *Metiochodes trilineatus*, sp. nov. (Fig. 10)

Type: St. Martins, Rangala, 18-IV-1930, 1 ♀.

Size and general shape of the preceding species, but with a much less uniform coloration. Head light brownish above, adorned with three whitish lines, one in the middle and one behind each eye; two lines of the same colour extend along the antennal sockets and join at apex of the frontal rostrum; face yellow with a small brown transverse band uniting the eyes on the facial shield. Eyes a little lengthened horizontally. Palpi yellowish, the 5th joint of the maxillary ones rather short, triangular. Antennae yellow.

Pronotum a little narrowing in front, with anterior margin nearly straight, posterior margin feebly sinuated; disc light brown, a little shining, bearing a few long bristles and adorned with three whitish bands in prolongation of those of the head; anterior and posterior margins also narrowly lined with whitish; lateral lobes yellowish with much rounded anterior angle. Abdomen and cerci yellowish. Ovipositor long, very feebly curved, with apical valves occupying nearly half the total length; their margins are first parallel, then converging in the apical third, the converging part strongly denticulated.

Legs yellowish with a brown pubescence. Anterior tibiae perforated with a large internal tympanum and a much smaller external one; median tibiae adorned with a fine brown longitudinal external line. Posterior femora presenting a small brown longitudinal band in the middle of the external face and a small oblique spot near the apex; tibiae with a small brown line at base of the external face, the spines and the large apical spurs brown on the inner side.

Elytra narrow, lengthened, pubescent, brown, with the veins standing out in yellow; dorsal field presenting four almost longitudinal veins, the 1st united to the second one by a false vein which terminates on the edge, the 4th furcate near the apex; lateral field lighter than the dorsal field, showing four regularly spaced veins. Wings brown, exceeding the elytra by a length equal to about half their own length.

Length of body 6 mm.; length with wings 10.5 mm.; elytra 5.5 mm.; ovipositor 3.2 mm.

This species seems to belong to the same genus as the preceding one although the head and the maxillary palpi do not resemble so closely the *Cyrtoxipha* type. It is very easy to distinguish by its coloration and by the longer and less curved ovipositor.

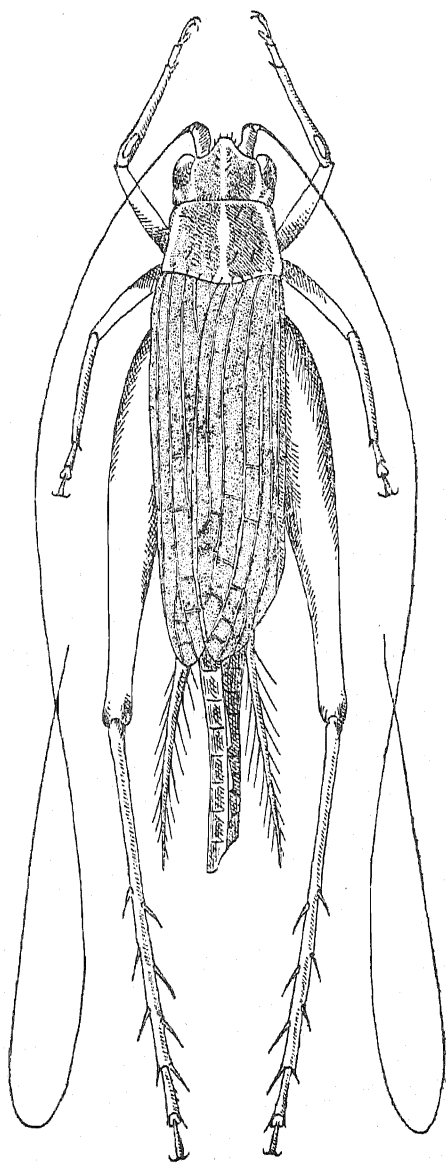


Fig. 10. *Metiochodes trilineatus*, sp. nov.

Genus *Amusurgus* Br. 189356. *Amusurgus oedemeroides* (Walk.)

*Eneoptera oedemeroides* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, suppl. p. 11  
*Amusurgus oedemeroides* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 527.  
fig. 23

Kandy, V-1933; Woodside, Urugalla, IV-1930; Labugama, III-1931; Madola near Opanake, II-1933; Colombo, V-1932; Vavuniya-Madawachchiya, I-1933; Battaramulla, V-1931; Kanniyai, Trincomalee, IV-1931.

A species described from Ceylon, which has since been found in India and Burma.

57. *Amusurgus speculifer*, sp. nov. (Fig. 11)

Type: Labugama, 9-III-1931, 1 ♂.

Small, testaceous, pubescent. Head yellowish, forehead a little flattened; frontal rostrum a little narrower than the first antennal joint; face yellow, triangular. Palpi and antennae yellowish; 5th joint of the maxillary palpi longer than the 4th, triangular. Eyes rather big, feebly lengthened dorso-ventrally. Pronotum a little narrowing in front, with anterior margin straight, posterior margin feebly sinuated; disc convex, a little shining, testaceous yellow, with a fine pubescence and a few long rufous bristles; lateral lobes concolorous, rounded forwards. Abdomen yellow.

Legs yellowish, rather long, pubescent. Anterior tibiae perforated on both sides. Posterior tibiae with supero-internal apical spur relatively short and thick.

Elytra yellowish testaceous, finely pubescent. Venation quite peculiar and interesting; chords non-differentiated, representing three feebly oblique, almost equidistant, veins; one rather neatly defined oblique vein; diagonal vein emerging as a branch of the 1st chord and divided to form a long, quite neat mirror; lateral field almost transparent, presenting three complete and one incomplete veins. Wings rather long, pubescent.

Length of body 6 mm.; length with wings 9 mm.; posterior femur 4.5 mm.

This species is quite remarkable by its elytral venation which helps one to understand how the mirror is formed in the Gryllids.

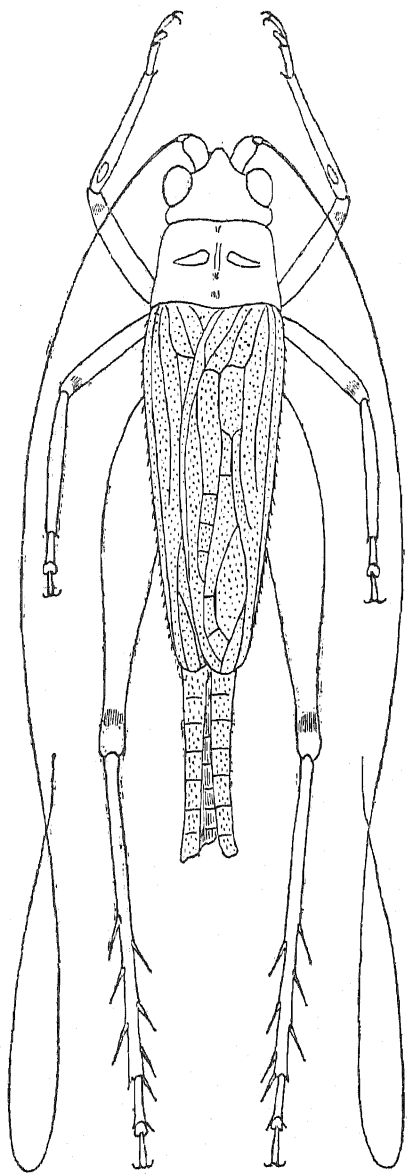


Fig. 11. *Amusurgus speculifer*, sp. nov.

Genus **Paranaxipha** Chop. 192558. **Paranaxipha ornatipes** Chop.

*Paranaxipha ornatipes* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 528, fig. 24

Labugama, VIII-1932, I-1933; Ratnapura, IX-1929; Kanniyai, Trincomalee, IV-1931; Haldummulla, VI-1926; Wellawaya, XII-1927; Mihintale, VII-1927; Kandy, VI-1910 (type).

A very distinct species known from Ceylon only.

Genus **Trigonidomorpha** Chop. 192559. **Trigonidomorpha fuscifrons**, sp. nov. (Fig. 12)

Type: Bandarawela, 11-IV-1931, 1 ♂.

Very small, testaceous, a little adorned with brown. Head convex; occiput adorned with a divided brown band; forehead brown from the middle of the eyes to the apex of the rostrum; face yellow with a brown band beneath each eye and another band of the same colour in the middle, widening on the facial shield between the antennae. Palpi yellowish, the 5th joint of the maxillary palpi a little longer than the 4th, triangular, wide. Antennae yellowish with two first joints brown.

Pronotum transverse with anterior and posterior margins straight, parallel sides; disc dark testaceous, strongly darkened in front; lateral lobes, concolorous, with inferior margin slightly sinuated in the middle, rounded angles. Abdomen testaceous; subgenital plate large with a small projection in the middle of the posterior margin. I have been unable to dissect the genitalia but they seem large, in the shape of a small horn.

Legs of the same colour as the body, rather long and strong, pubescent. Anterior tibiae non-perforated but feebly depressed at internal face. Posterior femora rather short and thick.

Elytra yellowish brown, nearly transparent with weak, lighter veins; venation comprising the anal vein, one oblique short vein, and four longitudinal veins which are a little irregular, the two first ones representing the chords which are united about the apical third. The venation of the left elytron is faint and very irregular.

Length of body 4 mm.; posterior femur 3.5 mm.

This small species exhibits a very peculiar venation which strongly reminds one of the typical species of the genus *Trigonidomorpha* (*T. sjöstedti* Chop.) but it is quite different from this species in its coloration.

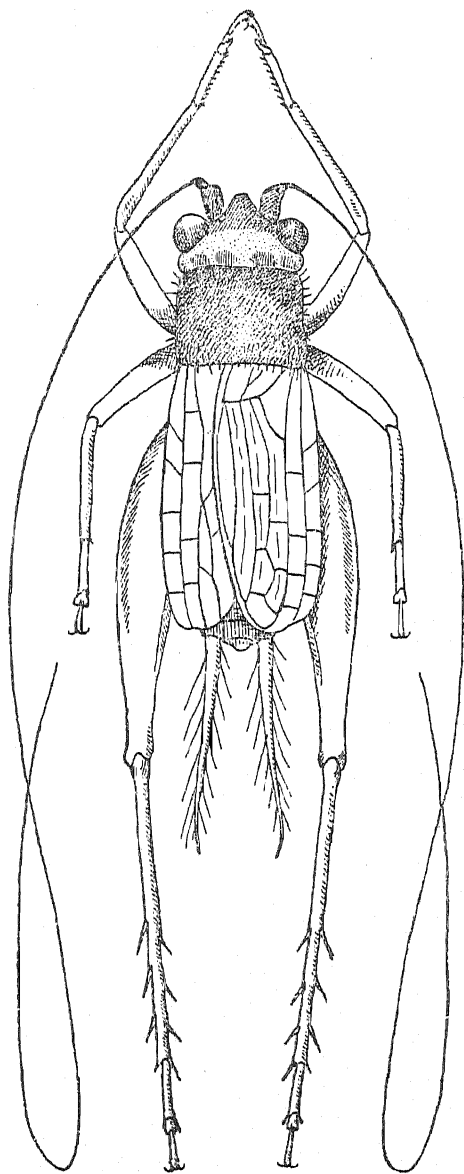


Fig. 12. *Trigonidomorpha fuscifrons*, sp. nov.

Genus *Homoeoxipha* Sauss. 187460. *Homoeoxipha lycoides* (Walk.)

- Phyllopalpus lycoides* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 71  
*Homoeoxipha lycoides* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 532  
*Homoeoxipha histrio* Saussure, 1878. *Mém. Soc. Genève*, XXV, p. 467  
*Cyrtosiphus ritsemæ*, Saussure, 1878. *Loc. cit.*, p. 485

Colombo, VI-1931; Marichchukkaddi, III-1933; Kandy, IV-1926; Haputale, 4,900 feet; Peradeniya; Pundalu-oya.

This species was described from Ceylon; it is common and widely distributed in the Oriental region.

Genus *Anaxipha* Sauss. 1874

## KEY TO THE SPECIES

1. Body and elytra very pubescent; male elytron with very long and rather narrow mirror . . . . . *pubescens*
- Body feebly pubescent; elytra glabrous . . . . . 2
2. Posterior femora long; general shape long and slender; male mirror much longer than wide; female with rather narrow elytra, a little longer than the body, with feebly projecting veins, transverse veinlets very conspicuous . . . . . *longipennis*
- Posterior femora short; general shape shorter and wider; male mirror scarcely longer than wide; elytra of the female extending not quite to the apex of abdomen, their veins projecting, quite parallel; transverse veinlets scarcely visible . . . . . *henryi*

61. *Anaxipha pubescens* Chop.

*Anaxipha pubescens* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 530, fig. 25

Peradeniya, XII-1910 (type).

This species has almost the same shape as the following one, but it is somewhat larger with shorter wings and the elytra are covered with an abundant pubescence. I only know the type specimen of this interesting species.

62. *Anaxipha longipennis* (Serv.)

*Trigonidium longipenne* Serville, 1839. *Ins. Orth.*, p. 351. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 530

*Cyrtoxiphus pusillus* Saussure, 1878. *Mém. Soc. Genève*, XXV, p. 486

Colombo, XI-1926, at light, II-III-1927, IX-1927, II-1928, IX-1929, at light; I-1932, at light; Battaramulla, I-1930; Kitulgala, IV-1927; Matale, XII-1928, IV-1932; Marichchukkaddi, III-1933; Marai Villu, III-1933; Arugam Bay, IV-1931; Peradeniya, Yatiyantota.

This species, described from Mauritius, seems to be one of the most widely spread *Trigonidiinae*, as it is found in Madagascar, East Africa and everywhere in tropical Asia. The micropterous form seems rather scarce and must be identical with *Cyrtoxiphus pusillus* Saussure, described from Ceylon.

63. *Anaxipha henryi*, sp. nov.

Type: Wellawaya, 28-IV-1931, 1 ♂. Allotype: 1 ♀ (same data).

♂ : Small, testaceous yellow. Head a little wider than the pronotum in front; forehead convex, little declivous; frontal rostrum a little narrower than the 1st antennal joint; face yellow. Antennae and palpi yellow; 5th joint of the maxillary palpi a little longer than the 4th, triangular, wide. Eyes rounded, projecting.

Pronotum very faintly narrowing in front, with anterior margin feebly convex, posterior margin straight; disc convex, testaceous with undefined rufous marks, bearing long bristles on small brown spots, chiefly along the anterior and posterior margins; lateral lobes concolorous with feebly sinuated inferior margin, anterior angle rounded. Abdomen yellowish; subgenital plate very wide; genitalia large, projecting in the shape of a forceps.

Legs relatively short, yellowish, pubescent. Anterior tibiae perforated on both sides. Posterior femora thick, presenting two small brown genicular spots; tibiae as long as the femora, with rather short, yellow spines.

Elytra testaceous, wide, extending to the apex of abdomen; mirror nearly as wide as long; diagonal vein short, sinuated; chords almost straight; lateral field nearly transparent, presenting four veins, one of which is very short. No wings.

♀ : Ovipositor short and wide, feebly curved, with apical valves occupying half the total length, finely denticulated.



Elytra extending to the apex of abdomen, a little convex; dorsal field presenting five very regular, parallel, projecting veins; transverse veinlets scarcely visible; lateral field as in the male. Wings completely aborted.

Length of body 5.5 mm.; posterior femur 4 mm.; ovipositor 2 mm.

The male of this species is very close to *A. vicina* Chop., from Philippines, but is easy to distinguish by an important character which has been omitted in the description of this last species (*Ann. Soc. Ent. Fr.*, 1925, p. 311); effectively, the 10th abdominal tergite of the male of *A. vicina* presents two small points on the posterior margin which do not exist in the Ceylonese species. As to the female, it looks very much like a *Rhynchogryllus* on account of its convex, somewhat horny elytra with parallel, somewhat projecting veins. The species also reminds one of certain *Paratrigonidium*, a genus which includes forms with very variable venation and which should probably be separated into several different genera.

#### Sub-family MYRMECOPHILINAE

The Myrmecophilinae are small, quite peculiar, Gryllids which live with ants in all parts of the world.

#### KEY TO THE GENERA

Inferior margin of posterior femora of the male provided with small tubercles; tibial spines and spurs, as well as the posterior metatarsus bearing a very long pubescence . . . . . *Myrmegryllus*

Inferior margin of posterior femora of the male smooth; tibial spines, spurs and posterior metatarsus without any special pubescence . . . . . *Myrmecophila*

#### Genus *Myrmecophila* Latr. 1828

#### 64. *Myrmecophila escherichi* Schimm.

*Myrmecophila escherichi* Schimmer, 1911. *Termitenleben auf Ceylon*, p. 235, fig. 61

This species was described from a very young larva 1.6 mm. long. the sex of which is not indicated. However it does not seem probable that it is a larval female of the following species as the posterior tibiae are provided with three internal spines only. Yet the species is doubtful and requires a complete description.

Genus *Myrmegryllus* Chop. 192865. *Myrmegryllus pilipes* Chop.

*Myrmegryllus pilipes* Chopard, 1928. *Rec. Ind. Mus.* XXX, p. 21, fig. 30.

*Myrmecophila dubia* Chopard (non Saussure), 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 519 (♀)

Colombo, V-1929, VI-1929, I-1931, V-1931; Peradeniya (type).

The female of this species had been overlooked as it presents no special feature on the posterior legs, the long hairs which cover the spines, spurs, and metatarsi of the male being a secondary sexual character limited to the male sex; the posterior femora are also plain without the small tubercles found in the male so that the insect is quite similar to a *Myrmecophila*; it can only be distinguished by the pubescence of the posterior metatarsi, which is a little more abundant; these metatarsi show three small spines which are completely hidden amongst the abnormal pubescence in the male. The 10th abdominal tergite is deeply notched, forming two small triangular lobes. Ovipositor rather long with very narrow, long apical valves; their margins parallel, their apex feebly notched. This female looks very much like *Myrmecophila dubia* Sauss. from Malay Peninsula and Sumatra, on account of the armature of the legs and the shape of the ovipositor; but it can be easily distinguished by the rather long hairs of the posterior metatarsus.

This species is known from Ceylon only.

## Sub-family MOGOPLISTINAE

The Mogoplistinae are small Gryllids with unarmed posterior tibiae and their body is covered with scales which come off very easily. Most of the species live on the ground among dead leaves, but some of them are found on shrubs.

## KEY TO THE GENERA

- |   |       |                       |
|---|-------|-----------------------|
| 1. Posterior metatarsus very long and almost unarmed above                                      | ..... | <i>Cycloptiloides</i> |
| — Posterior metatarsus rather short and armed with conspicuous denticles above                  | ..... | 2                     |
| 2. Pronotum of male extending more or less backwards, but covering almost completely the elytra | ..... | 3                     |
| — Pronotum of male extending but little backwards, the elytra uncovered                         | ..... | <i>Ornebius</i>       |

3. Pronotum of male nearly as wide in front as posteriorly; frontal protuberance very wide; antennae extremely slender . . . . . *Derectaotus*
- Pronotum of male narrowing in front; frontal protuberance not so wide; antennae not specially slender . . . . . *Eclatoderus*

Genus **Cycloptiloides** Sjöst. 1909

66. **Cycloptiloides orientalis** Chop.

*Cycloptiloides orientalis* Chopard, 1925. *Ann. Soc. Ent. Fr.*, XCIV, p. 301, figs. 19-24

*Cycloptiloides ceylonicus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 520, figs. 13-14

Mousakande, Gammaduwa, XI-1929; Battaramulla, II-1932; Bandarawela, IV-1931; Peradeniya (type of *ceylonicus*).

Having compared specimens of *Cycloptiloides* from Sumatra and Ceylon, I can find no difference between them and therefore conclude that *orientalis* and *ceylonicus* must be considered as the same species. In well preserved males, the 10th abdominal tergite is not so strongly notched as has been figured for *orientalis*.

Genus **Ornebius** Guér. 1844

67. **Ornebius guerini** (Bol.)

*Liphoplus guerini* Bolivar, 1900. *Ann. Soc. Ent. Fr.*, p. 801, pl. 12, fig. 25

*Liphoplus ceylonicus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 519, fig. 12

Trincomalee, IV-1931; Yala, XII-1931; Kandy, V-1933; Wellawaya, IV-1931; Peradeniya (type of *ceylonicus*).

The differences between South Indian and Ceylonese specimens are quite insignificant and do not justify their specific separation.

68. **Ornebius varipennis**, sp. nov.

Type: Marichchukkaddi, 10-III-1933, 1♂. Allotype: 1 ♀ (same data).

♂: Size rather small; rufous brown covered with greyish scales. Head with frontal rostrum a little wider than the 1st antennal joint, neatly furrowed. Maxillary palpi yellowish, the 4th joint shorter than the 3rd, 5th scarcely equalling the 3rd, funnel like, widening at top. Antennae yellowish.

Pronotum narrowing in front, a little produced backwards, with posterior margin feebly convex; disc rufous with greyish scales; lateral lobes covered with white scales. Abdomen dark brown covered with

yellowish grey scales which are mixed with small black scales. Anal valves with erect, very slender process. Subgenital plate with posterior margin rounded, subangulate in the middle.

Legs rather short, yellowish, covered with whitish scales. Anterior tibiae perforated with a small round tympanum at internal face. Posterior femora rather thick, without markings; tibiae short, serrulated; metatarsi presenting a rather strong serrulation above.

Elytra uncovered by pronotum from the angle of the mirror; dorsal field somewhat opalescent with posterior margin whitish, marked with three black spots; speculum large, occupying almost all the uncovered part of the elytron; lateral field blackish in its inferior half.

♀ (Allotype). Body and legs covered with greyish scales, a little varied with brown, as a whole darker than in the male. Pronotum a little longer than wide, very faintly narrowing in front; lateral lobes nearly white. Ovipositor straight, rather long, with superior apical valves smooth, inferior ones a little crenulated.

Length of body 5.5 mm.; posterior femur ♂ 3.5 mm., ♀ 4 mm.; pronotum ♂ 2.5 mm., ♀ 2 mm.; elytra 2 mm.; ovipositor 3 mm.

This species looks very much like the preceding one but is distinctly smaller; in the male, the elytra are more neatly spotted with white and black along the posterior margin; in the female the ovipositor is a little shorter.

#### Genus *Derectaotus*, gen. nov.

Close to *Ectatoderus*; pronotum of male a little produced backwards, almost as wide in front as behind; facial protuberance very wide; antennae extremely slender; elytra of male concealed beneath pronotum; anterior tibiae perforated at internal face.

This genus is intermediate between *Mogoplistes* and *Ectatoderus*; the pronotum of the male is produced and covers the elytra as in the latter, but the general shape very much reminds one of the former. The head with its very wide protuberance and extremely slender antennae particularly gives to these insects the facies of *Mogoplistes brunneus*.

#### KEY TO THE SPECIES

- |  |       |                   |
|--|-------|-------------------|
| 1. Maxillary palpi with 5th joint nearly as long as 4th        | ..... | <i>ceylonicus</i> |
| — Maxillary palpi with 5th joint much shorter than 4th         | ..... | 2                 |
| 2. Fifth joint of maxillary palpi very little widening at apex | ..... | <i>henryi</i>     |
| — Fifth joint of maxillary palpi triangular                    | ..... | <i>palpatus</i>   |

69. *Directaotus ceylonicus* (Chop.)

*Ornebius ceylonicus* Chopard, 1928. *Rec. Ind. Mus.*, XXX, p. 23, figs. 34 and 39 (♀)

Kandy, V-1933; Mousakaude, XI-1929.

This species was known from the female sex only. The male presents a pronotum nearly as wide in front as behind, with well rounded posterior margin, almost parallel sides; supero-anal valve very short, transverse; inferior ones bearing no process; subgenital plate with widely rounded posterior margin.

This species looks very much like the following one but it is readily distinguished by the shape of the maxillary palpi; however it must be stated that these are not quite so slender as indicated on the Fig. 34 of the recorded paper.

70. *Directaotus henryi* (Chop.)

*Cryptoptilum henryi* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 203, figs. 11-12

Known only from the male type specimen from Horowupotana.

71. *Directaotus palpatus*, sp. nov.

Type: Hakgala, 15-VIII-1929, 1 ♂. Allotype: 1 ♀.

♂: Size and shape of the preceding species; rufous brown covered with greyish scales varied with whitish scales. Head rounded with a slender whitish line along the eyes; frontal rostrum twice as wide as the 1st antennal joint, furrowed in the middle; face russet yellow. Maxillary palpi with 4th joint longer than 3rd, 5th short but very wide at apex, quite triangular in shape. Antennae very slender, yellowish with a small brown ring here and there.

Pronotum feebly narrowing in front, rather strongly produced and rounded backwards, with very feebly convex sides; disc rufous covered with brown and white scales, the latter forming faintly marked bands; lateral lobes blackish. Abdomen varied with brown and whitish with a few small black points on the posterior margin of the tergites; supero-anal valves rounded at apex; subgenital plate with widely rounded posterior margin.

Legs varied with brown and whitish. Anterior and median tibiae brown with two yellow rings, the anterior ones perforated with a rather large tympanum at base of the internal face. Posterior femora thick,

brown mottled with white; posterior metatarsi rather long, denticulated above, 3rd joint long and slender. Elytra completely hidden by the pronotum.

♀ (Allotype). The body is a little more varied in colour than in the male on account of the better conservation of the squamose covering. Pronotum as long as wide, a little narrowing forward, with straight anterior and posterior margins. Subgenital plate large, carinated in the middle, notched at apex and forming two large rounded lobes. Ovipositor short, thick, gently curved from the base, its apical valves lanceolate, acute at apex with smooth margins.

Length of body 7.5 mm.; pronotum ♀ 4 mm., ♂ 2.5 mm.; posterior femur 5.5 mm.; ovipositor 4 mm.

This species is very close to *ceylonicus*, but the maxillary palpi are different and the pronotum of the male is a little narrower in front. It also differs from *D. henryi* in the shape of the palpi and in the posterior metatarsus, which is more slender.

#### Genus *Ectatoderus* Guér. 1849

#### 72. *Ectatoderus ceylonicus* Chop.

*Ectatoderus ceylonicus* Chopard, 1928. *Spol. Zeyl.* XIV, p. 202, figs. 7-10

Kalkudah, IV-1931; Barberyn Id, XII-1926; Horowupotana, X-1924 (type).

This species looks like the preceding ones with respect to the width of the frontal rostrum and the very slender antennae; but it differs from them in the male pronotum narrowing in front and the anal valves provided with a distinct process. The female can be confounded with that of *Derectaotus ceylonicus* only on account of the shape of the maxillary palpi, but it is larger with much longer ovipositor.

#### Sub-family PENTACENTRINAE

The *Pentacentrinae* are characterized by the situation of the antennae which are inserted much lower on the face than in the other *Gryllidae*. Two of the genera known in this sub-family are found in Ceylon.

#### KEY TO THE GENERA

- |   |                            |
|---|----------------------------|
| Size small; body convex; head rounded above;<br>veins of the male elytron somewhat irregular      | ..... <i>Pentacentrus</i>  |
| Size larger; body depressed; head flattened;<br>elytra of male with very straight, parallel veins | ..... <i>Homalogryllus</i> |

Genus **Pentacentrus** Sauss. 187873. **Pentacentrus pulchellus** Sauss.

*Pentacentrus pulchellus* Saussure, 1878. *Mém. Soc. Genève*, XXV, p. 401, pl. 17 (1), figs. 1-5. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 523, fig. 18

Mousakande, Gammaduwa, XI-1929; Maskeliya.

This species presents no tympanum at external face of the anterior tibiae; the females seem usually darker than the males with almost wholly brownish elytra.

Genus **Homalogryllus** Chop. 192574. **Homalogryllus depressus** Chop.

*Homalogryllus depressus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 523, figs. 19-21

Trincomalee, I-1912.

This very interesting species is known from the type specimen only.

## Sub-family OECANTHINAE

This sub-family includes very delicate insects with almost transparent elytra; they lay their eggs in the stems of different shrubs. One genus only occurs in Ceylon.

Genus **Oecanthus** Serv. 1831

## KEY TO THE SPECIES

- |  |       |                  |
|--|-------|------------------|
| 1. The two first antennal joints with a black point  | ..... | <i>henryi</i>    |
| — The two first antennal joints without black marking  | ..... | 2                |
| 2. Size larger (17 mm.); anterior tibiae very faintly dilated, the tympanum long and narrow        | ..... | <i>rufescens</i> |
| — Size smaller (14 mm.); anterior tibiae more strongly dilated at base, the tympanum not so narrow | ..... | <i>indicus</i>   |

**75. *Oecanthus indicus* Sauss.**

*Oecanthus indicus* Saussure, 1878. *Mém. Soc. Genève*, XXV, p. 454. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 523

Colombo, I-1931; Trincomalee; Peradeniya.

A species known from India and Java.

**76. *Oecanthus rufescens* Serv.**

*Oecanthus rufescens* Serville, 1839. *Ins. Orth.*, p. 361

Bandarawela, IV-1931.

This species is very close to the preceding but larger; it has been recorded from India, Java, Celebes, Australia; it is rather Malayan than Indian.

**77. *Oecanthus henryi*, sp. nov.**

Type: Wellawaya, VII-1930, 1 ♂. Allotype: Marichehukkadi, 14-III-1933, 1 ♀.

A little smaller and more slender than *O. pellucens*; greenish. First and second joints of antennae both marked with a small black point at internal face; occiput showing such a small point behind each eye. Cerci strongly swollen at base. Anterior tibiae very much dilated, the widened part occupying at least half the total length; tympani very large, lengthened. Posterior femora finely spotted with brown at external face; tibiae with spines, denticles and apical spurs black at top; three spines on each margin. All the tibiae are marked with a small black spot above, at base.

Elytra rather narrow, the mirror one and a half times as long as wide. Wings caudate.

♀ (Allotype). Similar to the male and showing the same small black spots. Elytra with rather distant, oblique, somewhat irregular veins; transverse veinlets forming large areolae, a little longer than wide. Wings caudate. Subgenital plate triangular, with apex a little rounded. Ovipositor rather short.

Length of body 9 mm.; length with wings 13 mm.; elytra, ♂ 9 mm., ♀ 8.5 mm.; ovipositor 4.5 mm.

This species is quite distinct by the very large tympani of the anterior tibiae and still more by the small black spots of the antennae and of the knee. I take much pleasure in dedicating it to Mr. G. M. Henry who has brought so much to our knowledge of the Ceylonese fauna.



## Sub-family PHALANGOPSINAE

This sub-family includes rather large insects with usually very long legs; they live in moist places, in decaying wood and some of them have been found in caves.

## KEY TO THE GENERA

1. Both sexes apterous; median spur of the posterior femora the longest on both sides . . . . . *Arachnomimus*
- Both sexes bearing elytra; supero-internal apical spur of the posterior tibiae longer than the median one . . . . . 2
2. Frontal rostrum wide . . . . . *Luzaropsis*
- Frontal rostrum narrow . . . . . *Seychellesia*

Genus *Arachnomimus* Sauss. 1897

## KEY TO THE SPECIES

1. Coloration rather dull, varied with testaceous and brown . . . . . 2
- Head, pronotum and legs bright rufous; meso-, meta-notum and abdomen black, with two large yellow spots on the meta-notum . . . . . *bicolor*
2. Antennae brownish with a large white ring at some distance from the base . . . . . *annulicornis*
- Antennae without white ring . . . . . *nietneri*

78. *Arachnomimus nietneri* (Sauss.)

*Arachnopsis nietneri* Saussure, 1878. *Mém. Soc. Genève*, XXV, p. 442. Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 522

W. Haputale, Ohiya, 6,000 ft., III-1933; IV-1928; Hakgala, VIII-1929; Wellawaya, I-1928; Bintenne, X-1928; Trincomalee, VII-1927; Mousakande, Gammaduwa, XI-1929; Peradeniya.

Known from Ceylon only.

79. *Arachnomimus bicolor* Chop.

*Arachnomimus bicolor* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 205, figs. 15-17

Horowupotana, X-1924; Vavuniya, XII-1923.

A small species, quite easily distinguished from the preceding one by its peculiar coloration.

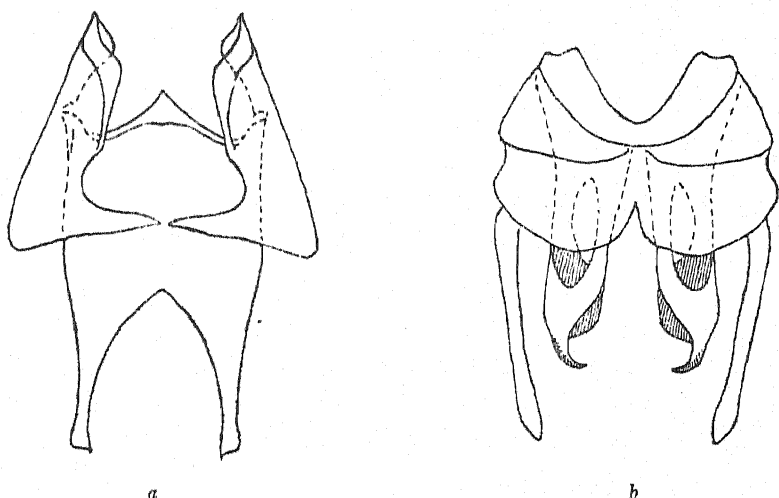


Fig. 13. Genitalia of a *Arachnomimus nietneri* (Sauss.). b *A annulicornis*, sp. nov.

80. ***Arachnomimus annulicornis*, sp. nov.**

Type: Buttala, Uva P., X-1931, 1 ♂. Paratypes: Bintenne, X-1928, 2 ♂.

Testaceous, varied with brown. Head with very narrow frontal rostrum: eyes strongly projecting laterally; face yellow with a brown band on each side on the base of the mandibles, along the facial shield, ending in a point between the antennal sockets. Maxillary palpi extremely long and slender, the 5th joint a little widened at top. Antennae rather thick, brownish with a large white ring at about 35 millimeters from base.

Pronotum transverse with anterior margin feebly notched in the middle, posterior margin straight; disc convex, a little irregular, yellowish, darkened on the sides: lateral lobes with inferior margin strongly ascending backwards, brown with yellowish anterior angle. Mesonotum short, brown. Metanotum yellowish marked with brown at base and on the sides. Abdominal tergites darkened along their posterior margin. Cerci very long. Genitalia formed on each side by a hook-like piece and a large superior piece bearing a very long lateral process.

Legs very long and slender. Anterior and median femora brown at apex with a large, light ring proximal to it; tibiae adorned with three brown rings, the anterior ones non-perforated; metatarsi extremely long

and slender, yellowish at base, brown at apex; 2nd and 3rd joints relatively short. Posterior femora long, feebly dilated at base, with parallel apical part extending to almost half the total length, their external face adorned with two oblique brown bands, their apex darkened; tibiae adorned with four brown rings, serrulated on their whole length, armed with three small spines on each margin; apical spurs rather short except the medio-internal one which is long and a little curved; medio-external one also a little longer than the other two; metatarsi very long, a little compressed.

Length of body (with retracted abdomen) 12 mm.; anterior femur 13 mm.; posterior femur 18 mm.; posterior tibia 20 mm.

This species is close to *A. nietneri*, but a little larger and with quite different genitalia (Fig. 13 *a* and *b*); it is also very easy to distinguish by the peculiar colour of the antennae.

#### Genus **Luzaropsis** Chop. 1925

The species belonging to this genus present a wide frontal rostrum which gives them the appearance of certain *Encopterinae*, a sub-family in which they were formerly placed; but the very small second joint of the tarsi is an important feature which justifies their inclusion among the *Phalangopsinae*.

##### KEY TO THE SPECIES

- |   |                         |
|---|-------------------------|
| Elytral venation of the male with a trace of differentiation, the anal vein and the chords visible; elytra of female with nearly straight internal margin | ..... <i>ferruginea</i> |
| Elytral venation of male without any differentiation; elytra of female with strongly oblique internal margin  | ..... <i>henryi</i>     |

#### 81. **Luzaropsis ferruginea** (Walk.)

*Luzara* (?) *ferruginea* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I. p. 103

*Luzaropsis ferruginea* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 521, figs. 15-17

Labugama, VI-1932, VIII-1932; Wellawaya, IV-1931; Kandy. I-1931, V-1933; Mousakande, Gammaduwa, XI-1929.

#### 82. **Luzaropsis henryi** Chop.

*Luzaropsis henryi* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 203, pl. XV, figs. 13-14

Trincomalee, IV-1931; Marichchukkadi, III-1933; Horowupotana, X-1924 (type).

Both species of the genus *Luzaropsis* are known from Ceylon only.

Genus *Seychellesia* Bol. 191283. *Seychellesia ceylonica*, sp. nov. (Fig. 15)

Type: Labugama, 21-I-1930, 1 ♂. Allotype: 1 ♀ (same data).

♂: Size medium; rufous brown, shining. Head as wide as pronotum; occiput convex, short, rufous; frontal rostrum a little narrower than the first antennal joint, compressed, furrowed in the middle; lateral ocelli at base of the rostrum, very close; anterior one a little before the apex in the bottom of a small depression; face rufous with a yellow median band. Palpi rather short, slender; 4th joint of the maxillary palpi a little shorter than 3rd, 5th somewhat longer, feebly enlarged at apex. Antennae brown, very slender with very long joints. Eyes strongly projecting forwards so that the vertex is hollowed to lodge the 1st antennal joint.

Pronotum transverse with nearly straight anterior margin, posterior one very faintly concave, both ciliated; disc irregular, rufous brown with a yellowish band, rather indistinct, on each side; lateral lobes concolorous, with inferior margin strongly ascending backwards, anterior angle subacute. Abdomen rufo-testaceous varied with brown; subgenital plate very long, subacute at apex. Cerci very long. Genitalia very long, projecting in the shape of a double, somewhat curved point (Fig. 14).

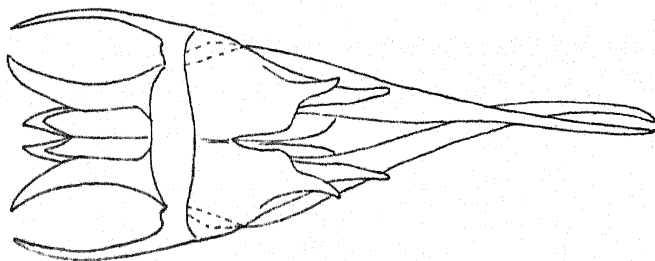


Fig. 14. Genitalia of *Seychellesia ceylonica*, sp. nov.

Legs rather short, rufous, slightly pubescent and presenting a few short bristles. Anterior and median femora with relatively thick base; anterior tibiae perforated with a small round tympanum at internal face; tarsi long, metatarsus yellow at base, a little longer than the other two joints united. Posterior femora strongly swollen at base, with almost no filiform apical part, presenting a large brown spot at their internal face; tibiae annulated with brown, serrulated and armed with three small internal, four external spines towards the apex; external apical spurs very short, the median one a little longer than the other

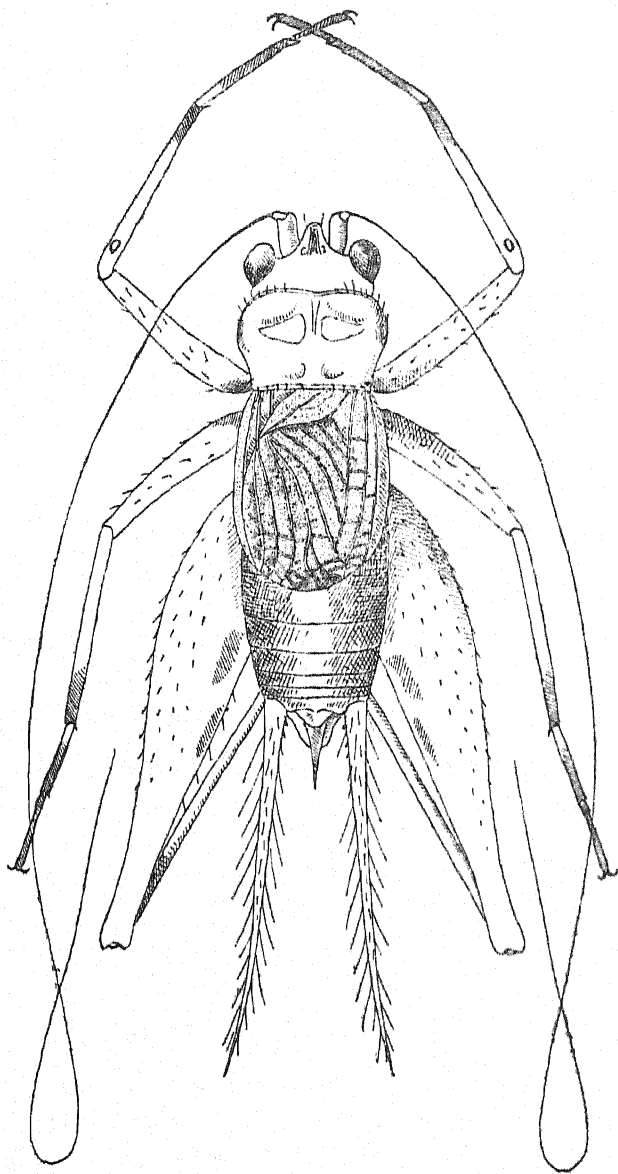


Fig. 15. *Seychellesia ceylonica*, sp. nov.

two; infero-internal spur short, median and superior ones rather long, equal in length; metatarsi feebly compressed, armed with three or four small denticles at external margin; 3rd joint very long and slender.

Elytra covering half of the abdomen, much rounded at apex, brown with rufous veins; dorsal field showing distinctly the anal veins and the chords only; the mirror and the oblique veins confused; lateral field presenting three plain veins. No wings.

♀ (Allotype). General shape as in the male; coloration more varied with brown spots. Subgenital plate small, a little notched at apex. Ovipositor long and slender, straight, with apical valves ovato-lanceolate, rather wide at base and suddenly narrowing towards the apex. Elytra almost as long as in the male, with oblique internal margin; dorsal field spotted with brown, with five straight, plain, rather projecting veins; transverse veinlets not numerous and feebly visible; lateral field as in the male.

Length of body ♂ 11.5 mm., ♀ 13 mm.; posterior femur ♂ 10.5 mm., ♀ 11 mm.; elytra ♂ 4.5 mm., ♀ 5 mm.; ovipositor 14 mm.

This species seems perfectly to agree with the genus *Seychellesia* created by Bolivar for species from the Seychelles Islands; the general shape, the shortness of the legs, the shining aspect remind one of *S. nitidula*, from which however the characters of the elytral venation allow it to be distinguished easily.

#### Sub-family ITARINAE

This sub-family includes one genus only in Ceylon

#### Genus *Heterotrypus* Sauss. 1878

##### KEY TO THE SPECIES

- |   |       |                |
|---|-------|----------------|
| Shape wide; coloration brownish with feebly visible spots   | ..... | <i>vicinus</i> |
| General shape much narrower, chiefly in the male; markings of the body and of the legs more visible | ..... | <i>elegans</i> |

#### 84. *Heterotrypus vicinus* Chop.

*Heterotrypus vicinus* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 206, pl. 16, figs. 18-22

Madola near Opanake, II-1933; Labugama, VIII-1932; Urugalla, IV-1924 (type).

85. *Heterotrypus elegans*, sp. nov. (Figs. 16 and 17)

Type: Kitulgala, 12-IV-1927, on island rocks in the river, 1 ♂.  
Allotype: Belihuloya, 1,800 ft., 31-VIII-1928, 1 ♀.

♂ : Size medium; general shape rather elongate; coloration dark brown varied with testaceous. Head a little narrower than pronotum; occiput testaceous with six longitudinal brown lines, the two median ones wider and united forwards on the frontal rostrum; this is narrow, with the two lateral ocelli, rather large, at base, the anterior one at apex; face testaceous with two narrow brown lines extending from the vertex to the labrum; cheeks marked with brown beneath the eyes. Palpi testaceous, rather long, the 4th joint of the maxillary ones shorter than 3rd, 5th weakly enlarged at apex. Antennae brown, very long and slender. Eyes projecting forwards.

Pronotum transverse with feebly convex anterior margin, sinuated posterior one; disc convex, irregular, dark brown, a little shining, with hollowed, lighter median line; lateral lobes with inferior margin ascending backwards, presenting a somewhat irregular yellowish band in the middle. Abdomen black above, yellowish beneath; supero-anal valve triangular, rounded at apex; subgenital plate with rounded posterior margin. Cerci very long, brown, yellowish at base. Genitalia rather plain, composed of a large superior piece, notched in the middle and each lobe furcate at apex, and a small inferior piece (Fig. 16).

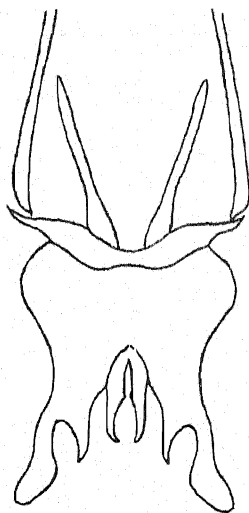


Fig. 16. Genitalia of *Heterotrypus elegans*, sp. nov.

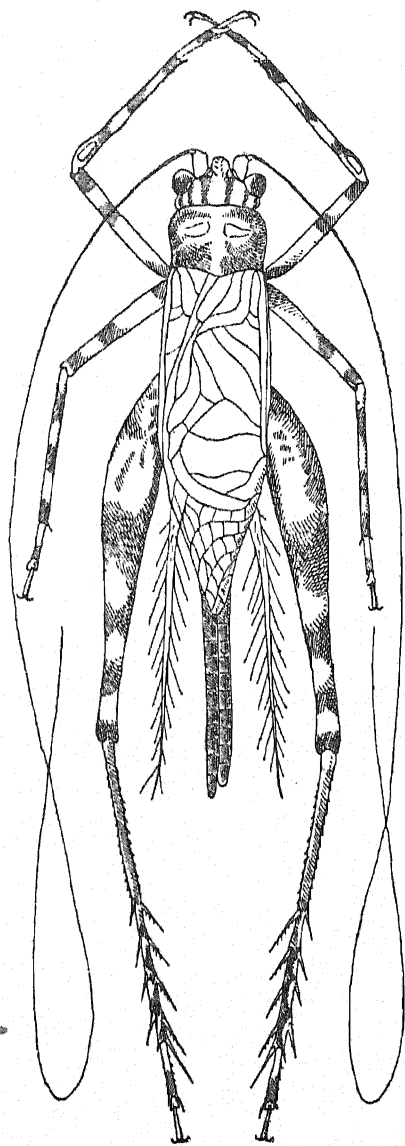


Fig. 17. *Heterotrypus elegans*, sp. nov.



Legs long, very neatly annulated with testaceous yellow and brown. Anterior tibiae perforated on each face at base with a small oval tympanum; anterior and median metatarsi moderately long, equalling the 3rd joint. Posterior femora rather thick at base, slender at apex, a little striated with brown at external face and adorned with two brown rings before the apex. Tibiae weakly serrulated and armed with four long, hairy spines on each margin; apical spurs testaceous, infero- and supero-external ones short, the median one longer; supero-internal spur equalling the metatarsus, median one a little shorter; metatarsi compressed, serrulated on the external margin only.

Elytra long and relatively narrow, dark brown; speculum as wide as long, almost pentagonal in shape, divided by two veins into three nearly equal parts; chords very short, the two first ones united at base, strongly diverging afterwards; diagonal vein very short; anal field long, the anal vein with much rounded angle; four oblique veins, rather regularly spaced; apical field long, presenting four sectors and a wide reticulation; lateral field almost transparent with a brown band in its superior part; mediastinal vein bearing about ten parallel branches. Wings lengthily caudate.

♀: Head, thorax and legs as in the male. Subgenital plate small, feebly notched at apex. Ovipositor short with apical valves presenting a large basal tooth, a smaller distal one and two apical ones.

Elytra rather narrow; dorsal field presenting three free veins and five branches of the discoidal; these are nearly transverse, regularly distant; transverse veinlets a little curved, forming large, lengthened areolae; lateral field much less developed than in the male, the mediastinal vein bearing eight more oblique branches. Wings caudate.

Length of body 14 mm.; length with wings 29 mm.; posterior femur 15 mm.; elytra 17 mm.; ovipositor 7.5 mm.

This species is remarkable by its long shape, especially in the male, which at first sight somewhat reminds one of certain forms of the genus *Madasumma*. Besides the types, there are several individuals from the same locality in the collection; the males exhibit a certain variation in the elytral venation; the oblique veins are sometimes three only in number, the 1st chord is not always united to the mirror, which has been found in one specimen divided by one vein instead of two.

## Sub-family ENEOPTERINAE

Genus *Cardiodactylus* Sauss. 187886. *Cardiodactylus praecipuus* (Walk.)

*Platydictylus praecipuus* Walker, 1869. *Cat. Derm. Salt. Br. M.*, I, p. 83

*Madasumma praecipua* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 533

I have seen the type specimen of this species which is very close to *Cardiodactylus novae-guineae*, but with more slender ovipositor, the superior valves of which are finely denticulated. This species was recorded by Walker from Ceylon without exact locality; it has never been found since then.

## Sub-family PODOSCIRTINAE

## KEY TO THE GENERA

- |  |                         |
|--|-------------------------|
| 1. General shape linear; head as wide or wider than pronotum; male elytra without tympanum     | ..... 2                 |
| — General shape wider with smaller head; male elytra with a distinct tympanum                  | ..... 3                 |
| 2. Veins of elytra quite longitudinal and regularly spaced, eyes lengthened antero-posteriorly | ..... <i>Patiscus</i>   |
| — Veins of elytra oblique and somewhat irregular; eyes globular                                | ..... <i>Euscirtus</i>  |
| 3. Anterior tibiae fusiform, strongly swollen at base with open tympanum on each side          | ..... <i>Mnesibulus</i> |
| — Anterior tibiae subquadrate, scarcely dilated at base; internal tympanum partly covered      | ..... <i>Madasumma</i>  |

Genus *Madasumma* Walk. 1869

## KEY TO THE SPECIES

- |  |                            |
|--|----------------------------|
| 1. Males   | ..... 2                    |
| — Females  | ..... 6                    |
| 2. Elytral speculum about one and a half times as long as wide                     | ..... 3                    |
| — Elytral speculum scarcely longer than wide                                       | ..... 5                    |
| 3. Larger size (from head to tip of wings 33 mm.; seven oblique veins (3 + 4))     | ..... <i>valida</i>        |
| — Smaller size (no more than 26 mm.); five to seven oblique veins (2 + 1 + 2 or 4) | ..... 4                    |
| 4. Elytra with a few opaque white spots  | ..... <i>marginipennis</i> |
| — Elytra without opaque spots  | ..... <i>varipennis</i>    |
| 5. Anterior tibiae a little swollen at base; elytral spots of a pure white         | ..... <i>albonotatus</i>   |
| — Anterior tibiae not at all dilated at base; elytral spots yellowish              | ..... <i>greeni</i>        |

6. General shape narrow and long; apical valves of ovipositor regularly and rather finely denticulated beneath; posterior femora mottled with brown . . . . . *varipennis*
- General size wider; posterior femora almost unicolorous . . . . . 7
7. Veins of elytra stronger; transverse veinlets more regular, forming nearly square areolae; ovipositor shorter with apical valves strongly denticulated beneath . . . . . *marginipennis*
- Veins of elytra weaker; transverse veinlets numerous, forming a very irregular reticulation; ovipositor longer with not so strongly denticulated apical valves . . . . . *greeni*

### 87. *Madasumma marginipennis* (Guér.)

*Platydyctylus marginipennis* Guérin, 1844. *Icon. R. An. Ins.*, p. 330

*Madasumma marginipennis* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 533, figs. 27-28-31

Battaramulla, II-1930, XI-1929, I-1930, V-1932; Buttala, X-1931; Bintenne, X-1928; Butawa Modera, XII-1931; Yala, XII-1931; Marichehukkaddi, III-1933; Rakwana, IV-1929; Maraj Villu, III-1933; Peradeniya; Wellawaya.

### 88. *Madasumma greeni* Chop.

*Madasumma greeni* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 533, figs. 27b, 29-30

Kandy, V-1909, V-1910 (types).

The differences between the above two species of *Madasumma* have been given in the description of *M. greeni*; it must be noted that the figures of apex of ovipositor have been inverted.

### 89. *Madasumma albonotata*, sp. nov.

Type: Kitulgala, 8-IV-1927, 1 ♂

Close to *marginipennis*; testaceous with very neat white spots on the elytra. Head small, rufous; frontal rostrum a little narrower than the 1st antennal joint, flat above with feebly converging, keeled margins; ocelli very close, the lateral ones rather big, oval, the anterior one small, at base of the rostrum; face yellowish, oblique, the facial shield coming, between the antennae, nearly to a point. Palpi yellow; 4th joint shorter than 3rd, 5th rather long, widened and obliquely truncated at apex, presenting a brown ring about the apical third. Antennae rufo-testaceous.

Pronotum a little narrowing in front, with straight anterior margin, posterior one a little sinuated; disc rufous brown, feebly convex, slightly irregular, the anterior and posterior margins yellowish marked with small brown spots; lateral lobes wholly yellowish, with widely rounded anterior angle. Abdomen brownish above, yellowish beneath; 10th tergite yellow, truncated at apex and presenting two small tubercles in the middle; supero-anal valve rounded and presenting also two small tubercles at base; subgenital plate wide, with posterior margin sinuated, bluntly narrowing and angular at apex. Genitalia of the same type as *greeni* but less deeply notched at apex (Fig. 18).

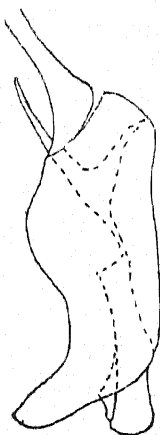


Fig. 18. Genitalia of *Madasumma albonotata*, sp. nov.

Legs yellowish, pubescent. Anterior tibiae rather strongly dilated at base with large, oval external tympanum, internal one in the bottom of a deep depression. Posterior femora lengthened and feebly dilated at base; tibiae armed with six spines on each margin, the internal longer than the external ones and a little hooked at apex.

Elytra long but rather wide, rufo-testaceous, presenting three large spots of a very pure white, one on the shoulder, a large one occupying all the posterior part of the anal field, one beneath the mirror in the external angle; besides there are two smaller spots along the edge; speculum nearly as wide as long, regularly rounded backwards, a little angulate forwards; chords short, strongly curved, slightly diverging; diagonal vein short, a little broken near the base; six oblique veins, of which two are long, parallel, one coming from the middle of the anal vein, the others in the angle; apical field long, presenting four sectors, and reticulated into wide, nearly square areolae; lateral field almost

transparent with mediastinal vein bearing numerous branches. Wings a little longer than elytra.

Length of body 12.5 mm.; length with wings 22 mm.; posterior femur 11 mm.; elytra 15 mm.

This species is very close to *M. greeni* but the spots of the elytra are of a pure white, the frontal rostrum is a little narrower, pronotum more strongly narrowing in front, legs not so pubescent with more fusiform anterior tibiae.

90. *Madasumma valida*, sp. nov.

Type: Labugama, 17-VI-1932, 1 ♂.

Same general habitus as the preceding species, but larger, the elytral spots feebly visible. Head small, rufous; frontal rostrum almost as wide as the 1st antennal joint; ocelli disposed as a triangle, equal, the anterior one nearly at base of the rostrum; face rufous. Palpi with 4th joint a little shorter than 3rd, 5th triangular, a little darkened at apex. Antennae varied with yellow and brown.

Pronotum almost cylindrical, with straight anterior margin, posterior margin sinuated; disc regularly convex, adorned with a few brown spots in front, the usual impressions lined with brown; lateral lobes lighter than the disc, with rounded inferior margin. Abdomen brown above, yellowish beneath; supero-anal valve small, rounded; subgenital plate lengthened, very narrow at apex. Genitalia rather plain, forming a long bifid piece (Fig. 19).

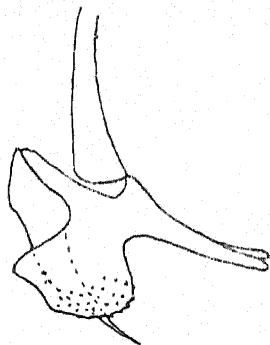


Fig. 19. Genitalia of *Madasumma valida*, sp. nov.

Legs rather long, very pubescent, a little mottled with brown. Anterior tibiae almost quadrangular, scarcely swollen at base. Posterior femora very long and very feebly dilated at base; tibiae armed with five spines on each margin.

Elytra lengthened, testaceous brown, almost unicolorous, slightly pubescent; anal field long; mirror much longer than wide, divided above the middle by a feebly curved vein; chords regularly curved; diagonal vein long; seven oblique veins, of which three are almost parallel, and four shorter ones from the angle of the anal vein; apical field long, reticulated in large, rectangular areolae. Wings a little longer than the elytra.

Length of body 25 mm.; length with elytra 34 mm.; posterior femur 14.5 mm.; elytra 23 mm.

Although close to the preceding, this species is easy to distinguish by its larger size and its more uniform coloration.

### 91. *Madasumma varipennis* (Walk.)

*Platydictylus varipennis* Walker, 1869. *Cat. Derm. Salt. Br. Mus.*, I, p. 84 (♂)

*Madasumma varipennis* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 533

*Madasumma incerta* Chopard, 1928. *Spol. Zeyl.*, XIV, p. 205, fig. 23 (♀)

Marichchukkaddi, III-1933; Horowupotana, X-1924 (type of the ♀).

I have compared in the British Museum collections the types of *incerta* and *varipennis* and have been able to ascertain that they are the two sexes of the same species. The male is less different from the other *Madasumma* than the female, although its general shape is rather narrow and its posterior legs relatively short. The head, the thorax and the abdomen are adorned, as in the female, with very characteristic blackish markings. The elytra are almost transparent with well marked veins; speculum lengthened, a little oblique, divided a little above the middle; chords rather strongly curved; four oblique veins only, of which two long, somewhat diverging, and two short ones, in the angle on the anal vein; apical field presenting four sectors broken at right angles, reticulated into large, irregular areolae.

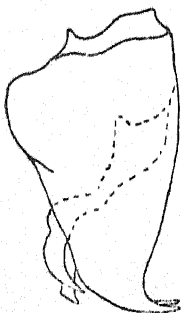


Fig. 20. Genitalia of *Madasumma varipennis* Walk.

Subgenital plate very long, narrow. Genitalia short, in the shape of a rather wide triangular piece, deeply notched at apex (Fig. 20).

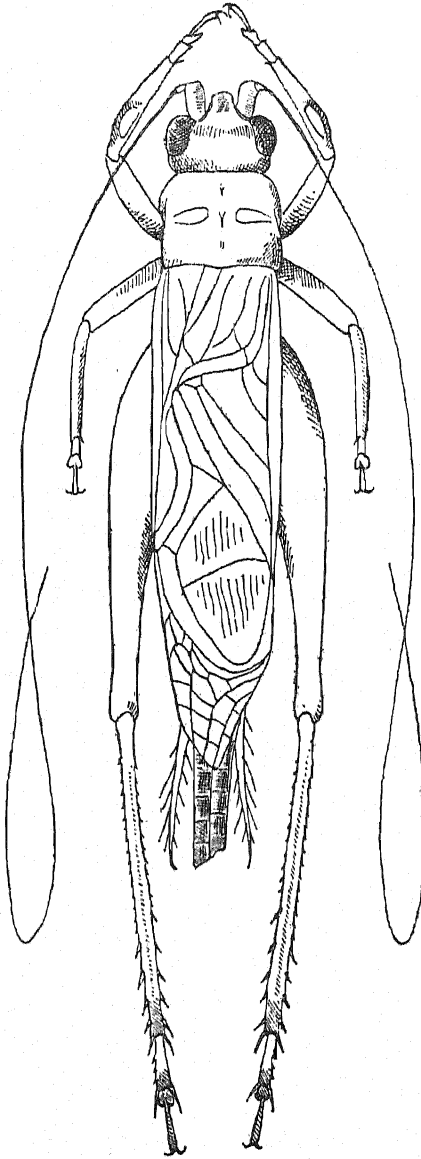


Fig. 21. *Mnesibulus pallipes*, sp. nov.

Genus *Mnesibulus* Stal.92. *Mnesibulus pallipes*, sp. nov. (Fig. 28)

Type: Madola, near Opanake, 23-II-1933, 1 ♂.

Narrow, lengthened, rufous brown with yellowish legs. Head as wide as pronotum, rufous, pubescent; forehead wide, flattened; ocelli very small, scarcely visible; face short, triangular, the superior part rufous, the inferior one yellow; clypeus very narrow. Palpi with 4th joint much shorter than 3rd, 5th a little longer, slightly enlarged at apex, brown. Antennae rufous.

Pronotum rufous, pubescent; anterior margin straight, posterior one feebly convex; disc regularly convex; lateral lobes concolorous, with straight inferior margin, rounded angles. Abdomen brown above, yellow beneath; anal segment truncated; subgenital plate moderately long, triangular. Genitalia short with a hook-like median piece (Fig. 22 *a* and *b*).

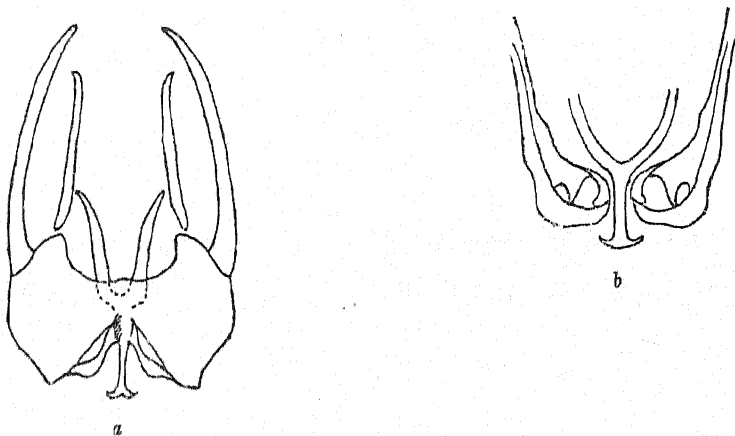


Fig. 22. *a* Genitalia of *Mnesibulus pallipes*, sp. nov. *b* Apex of same

Anterior and median legs rather short, yellowish; anterior tibiae rounded above, rather strongly dilated at base; external tympanum nearly rectangular, internal one in the bottom of a depression. Posterior femora rather long, presenting a trace of a rufous brown, wide ring before the apex; tibiae armed with four small external, five internal spines; metatarsi short, yellow with brown tops, armed above with three external denticles.

Elytra narrow, long, light brown, covered with a very fine and close pubescence; mirror very long, oblique, divided almost in the middle, with acute anterior angle, posterior part narrowing; chords very feebly



curved, the 1st one united to the mirror by a small vein; diagonal vein rather short, straight; four oblique veins, two long ones somewhat diverging, and two coming from the angle of the anal vein; apical field rather short, with three sectors, reticulated in large irregular areolae; mediastinal vein bearing eight branches. Wings a little longer than the elytra.

Length of body 11 mm.; length with wings 16 mm.; elytra 10.5 mm.

This species is rather close to *M. lineatus* Stal, but is somewhat larger with more uniform coloration and the legs lighter and yellowish.

### Genus *Euscyrtus* Guér. 1844

#### KEY TO THE SPECIES

1. Rather large species (about 20 mm. in length with wings); ovipositor very straight . . . . . 2
- Smaller species (about 15 mm.); ovipositor sinuated . . . . . 4
2. Frontal rostrum as wide as 1st antennal joint, with parallel margins . . . . . *laminifer*
- Frontal rostrum narrower, with sides a little converging . . . . . 3
3. Posterior femora long and slender; tibial armature weak; anterior tibiae perforated at internal face only; anterior angle of the lateral lobes of pronotum feebly rounded . . . . . *necydaloides*
- Posterior femora shorter and stouter; tibial armature stronger; anterior tibiae perforated on both sides; anterior angle of lateral lobes of pronotum much rounded . . . . . *perforatus*
4. Frontal rostrum as wide as 1st antennal joint; size smaller . . . . . *hemelytrus*
- Frontal rostrum narrower than 1st antennal joint; size a little larger . . . . . *concinus*

### 93. *Euscyrtus hemelytrus* (Haan)

*Gryllus* (*Eneoptera*) *hemelytrus* Haan, 1842. *Temm. Verh. Orth.*, p. 231, pl. 20, fig. 2.

Kandy, V-1933; Labugama, III-1931; Battaramulla, V-1931.

The best character to separate this species from the following one seems the width of the frontal rostrum which is much narrower in *concinus*. The size is usually a little smaller although it exhibits a

rather wide variability in *concinus*. The anterior tibiae are scarcely swollen at base. The elytra are shorter and the macropterous individuals are scarce; in this form, the elytra do not seem to exceed the abdominal end. The general coloration is the same in both species, but it is usually more marked in *hemelytrus*, the pale forms being much more common in *concinus*.

#### 94. *Euscyrtus concinnus* (Haan)

*Gryllus* (*Encoptera*) *concinus* Haan, 1842. *Temm. Verh. Orth.*, p. 231, pl. 20, fig. 3

*Euscyrtus concinnus* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 535

Galge, Uva, IV-1933; Labugama, I-1930; IX-1931; VIII-1932; Mihintale, VII-1927; Ratnapura, IX-1929; Colombo, II-1926, II-1929, IV-1931, X-1928, XI-1926, XII-1926, XII-1928; Battaramulla, I-1930; Marai Villu, III-1933; Haragama, II-1931; Marichechukkaddi, III-1933; Kitulgala, IV-1927; Kandy, IV-1926, IV-1931, V-1933; Andankulam, Trincomalee, IV-1931; Haputale (4,900 ft.), IV-1931; Peradeniya; Ambalagoda.

Like the preceding one, this species is widely spread over the Indian and Malayan regions extending as far as the Philippine islands.

#### 95. *Euscyrtus necydaloides* (Walk.)

*Oecanthus necydaloides* Walker, 1871. *Cat. Derm. Salt. Br. M.*, V, suppl., p. 15

*Euscyrtus necydaloides* Chopard, 1925. *Ann. Mag. Nat. Hist.* (9) XV, p. 535

Labugama, I-1930, VI-1932, VIII-1932; Peradeniya.

#### 96. *Euscyrtus laminifer*, sp. nov.

Type: Labugama, 15-IX-1931, 1 ♂. Allotype: Labugama, 15-18-VIII-1932, 1 ♀.

♂ : Rather large, testaceous yellow, with a wide brown band extending from the head to the apex of elytra. Head a little wider than the pronotum, adorned with a brown spot in the middle of the forehead; frontal rostrum nearly as wide as 1st antennal joint, with parallel margins; face yellow. Palpi short, 3rd and 4th joints equal in length, 5th a little longer, narrow, obliquely truncated at apex. Antennae yellowish with brown first joint. Eyes big, rounded; anterior ocellus in a depression near the apex of the rostrum.

Pronotum very feebly widening in front, with anterior margin a little concave, posterior margin sinuated; disc convex, presenting two transverse furrows, the posterior part feebly elevated; middle occupied by a brown band widening in the anterior third; lateral lobes yellow, with much rounded anterior angle, nearly straight inferior margin. Abdomen yellowish; subgenital plate very long but somewhat rounded at apex.

Legs yellowish, the anterior and median ones short; anterior tibiae perforated at internal face only. Posterior femora relatively short and stout; tibiae serrulated and armed with seven external, twelve internal blackish spines; metatarsi compressed, armed with two small apical spines and two spurs subequal in length.

Elytra presenting a dark brown band on their whole length; six slightly oblique veins, the 1st one curled on the 2nd about the middle, the 4th emerging from the angle, the 5th and 6th from the discoidal; transverse veinlets forming rather regular, almost square areolae; lateral field almost transparent, presenting two free veins and two branches of the mediastinal vein. Wings caudate, blackish.

♀ (Allotype). General shape not quite so slender as the male, coloration much more uniform; otherwise presenting the same general characters. Subgenital plate small, truncated at apex. Ovipositor very long, flat, acute at apex and very feebly curved upwards.

Length of body 13.5 mm.; length with wings 18 mm.; posterior femur 10.5 mm.; elytra 10.5 mm.; ovipositor 25 mm.

This species is distinguished by the shape of the frontal rostrum, the short posterior femora and the very long ovipositor which reaches in certain specimens the length of 29 millimeters. It is rather close to *E. longecaudatus* Chop. from Java, which is larger with almost straight ovipositor and the anterior tibiae perforated at external face.

Besides the types, the collection contains 1 ♂ and 4 ♀ from the same locality.

#### 97. *Euscyrtus perforatus*, sp. nov.

Type: Colombo, 20-IV-1931, 1 ♂.

Rather large, narrow, lengthened. Head a little wider than pronotum, cubical, light testaceous, adorned with two reddish brown bands on the median line, uniting on the rostrum; a band of the same colour is behind each eye; frontal rostrum narrow, with feebly converging sides. Face short, yellow, the facial shield a little lined with

reddish near the superior margin. Palpi very short, the 4th joint a little shorter than the 3rd, 5th narrow, securiform. Antennae brownish. Eyes rounded, projecting; ocelli very small, the anterior one in a small depression a little before the apex of the rostrum.

Pronotum with parallel sides, anterior margin feebly concave, posterior margin sinuated; disc convex, presenting two transverse furrows, adorned with a wide reddish brown median band; lateral lobes with much rounded anterior angle, adorned with a reddish brown band in their superior part. Abdomen yellowish; subgenital plate very long.

Anterior and median legs short; femora stout, especially the anterior ones; tibiae cylindrical, marked with a small brown spot on the knees, the anterior ones a little dilated at base and perforated with an oval tympanum on either side. Posterior femora relatively short and stout, slightly exceeding the apex of elytra; tibiae mottled with brown near the base, the denticles and spines for the most part blackish; spines rather strong, especially the internal ones, their number being nine internal, thirteen external; apical spurs very short on the external face, the two large internal ones subequal in length; metatarsi armed with two to three small external denticles, one internal only, the apical spurs very unequal in length; 3rd joint very slender.

Elytra as long as the body, testaceous; dorsal field presenting six regular, slightly oblique veins; transverse veinlets forming large, lengthened areolae; lateral field almost transparent, with somewhat reddish veins, of which two are free and two are branches of the mediastinal. Wings caudate.

Length of body 12 mm.; length with wings 18.5 mm.; posterior femur 9 mm.

This species differs from *E. necydaloides* in the smaller size of head, the shape of the lateral lobes of the pronotum and the much shorter posterior femora.

#### Genus *Patiscus* Stal. 1877

#### 98. *Patiscus quadripunctatus* Bol.

*Patiscus quadripunctatus* Bolivar, 1900. *Ann. Soc. Ent. Fr.*, LXVIII (1899), p. 806

Haputale, 4,900 ft., IV-1931.

This species was previously known from South India only; I have compared the Ceylonese specimen with the type in the Pantel collection; there is no difference whatever between them.

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The names of families genera and species are printed in Roman characters, the synonyms in italics.

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## The Snake *Oligodon albiventer* (Günther)

BY

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In 1864 Günther described a new Ceylon snake which he named *Simotes albiventer*. Subsequently Boulenger (1890) placed it in the synonymy for *Simotes arnensis* (Shaw). Wall (1921) accepts this opinion and states that in *Oligodon arnensis* (Shaw) the loreal is about as long as high. His figure depicts this scale separating the prefrontal from the labials, but as this author was more familiar with Indian snakes than with those from Ceylon, it is possible that his description and figure are derived from the former source.

Examination of a series of eleven Ceylon specimens has shown that the loreal is usually completely wanting and in a few it is vestigial, failing to separate the prefrontals from the labials.

A Ceylon specimen was referred to Mr. H. W. Parker of the British Museum, who after kindly examining the material in that institution, agrees with me that the Ceylon form should be recognized. The material in the British Museum which was kindly listed by Mr. Parker for me is as follows:—

### A. Loreals present, separating prefrontals from labials.

2 ♂♂, ♀,	2 juv.	India.
♀		Nepal.
	juv.	Sikkim.
♀		Deccan.
♂		Bombay.
	juv.	Deesa.
♂		Madras.
♂		Anamallays.
	juv.	Nepal.
♀		S. India.
♂		Neboda.
2 ♀♀, ♂,		Fyzabad.
2 ♂♂		Sehore.



## B. Loreals absent, prefrontals touching labials.

♀	Anamallays.
♂	Bangalore.
♀	?
♀	Ceylon.
♂	near Kandy, type of <i>S. albiventer</i> Günther.
♀	Kurunegala, Ceylon.
juv.	Chilaw, Ceylon.

The Ceylon material examined by me was as follows :—

(A) with loreals; prefrontals touching labials—Matugama (Western Province) three specimens.

(B) No loreals—Matugama five specimens, Colombo (Western Province) one; Nikaveratiya (North-Western Province) one; Marichchukkaddi (Northern Province) one; a ratio of eight specimens without loreals to three with vestigial ones.

It is thus evident that the Ceylon snake differs from the typical in possessing prefrontals always touching the labials, while the loreals are usually absent, and usually the number of black marks are considerably less than in Indian specimens. It is possible that the local form spreads some distance into South India, but it is equally probable that the two South Indian specimens, which lack loreals, are unusual.

In view of this, it is proposed to separate *Oligodon arnensis* (Shaw), into two subspecies, a northern which is the typical form and a southern, viz., *Oligodon arnensis albiventer* (Günther) of which the type is in the British Museum. The latter is the Ceylon form.

### ***Oligodon arnensis albiventer* (Günther)**

- Simotes purpurascens*, var. A, Günther, 1858. *Cat. Colubrine Snakes*, p. 25  
*Simotes albiventer* Günther, 1864. *Reptiles of Brit. India*, p. 214, pl. XX, fig. D  
*Simotes arnensis* Boulenger, 1890. *Fauna of Brit. India*. (Reptilia) p. 314 (in part)  
*Oligodon arnensis* Wall, 1921. *The Snakes of Ceylon*, p. 231, fig. 48

*Sinhalese* Kunu mi-karavela.

Prefrontals always touching labials, loreals usually absent. Ventrals 165 to 180. Subcaudals forty-one to fifty-five. About seventeen to nineteen black transverse bands dorsally on body and tail, the latter has in addition about seven spots in a longitudinal series, all dark marks with a light margin. Dorsal ground colour cinnamon-brown, sometimes without black marks. Ventrally white.

Distribution. Near Kandy (Central Province); (type locality), Colombo, Matugama (Western Province); Nikaveratiya (North-Western Province); Marichchukkaddi (Northern Province).

In conclusion I must express my thanks to Mr. H. W. Parker, of the British Museum (N. H.), for sending me information concerning specimens in the British Museum, to Mr. C. Karunaratne of the Agricultural Department, Peradeniya, for a specimen from Nikaveratiya and to G. Pillai for another from Marichchukkaddi.

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GÜNTHER, 1864—*Reptiles of British India*, p. 214, pl. XX, fig. D.  
WALL, 1921—*The Snakes of Ceylon*, p. 231, fig. 48
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## The Mole-rats (*Gunomys*) of Ceylon; with the description of a new race from the Jaffna Peninsula

BY

W. W. A. PHILLIPS, F.L.S., F.Z.S., M.B.O.U.

During a visit to the Jaffna Peninsula, the most northerly area of Ceylon, in December, 1934, I learnt that mole-rats, of the genus *Gunomys*, were common in and around the paddy-fields throughout the district. I was, however, unable to procure any specimens, during my visit, owing to the paddy being in full growth. The following March, after the paddy had been reaped, the Director, Colombo Museum, very kindly sent up a Collector to obtain as many specimens as he could find. In all, nineteen were obtained, the majority of them being, unfortunately, young or subadult.

This paper is the outcome of an examination of this material, together with twenty-three specimens labelled *Gunomys gracilis* from several localities in other parts of the Island and six specimens labelled *Gunomys kok* from the Indian mainland, the latter very kindly sent to me by the authorities of the Bombay Natural History Society. From a comparison of this material, it is immediately evident that all the specimens examined are referable to one species only. Presumably the Ceylon mole-rat, *Gunomys gracilis* was accorded full specific rank under the impression that it was confined to the highlands and the wet zone of Ceylon, and that no forms existed linking it with the southern mainland form *G. kok*.

Wroughton (1908), in his key to the distinguishing characters of the various species of Indian and Ceylon mole-rats, differentiates between *G. gracilis* and *G. kok* by stating that the length of the upper molar series in *gracilis* is 6.6 mm., while in *kok* it is 8 mm. or less. In the present specimens however, the length in *gracilis* varies from 6.1 mm. to 7 mm. and in *kok* from 6.3 mm. to 8 mm. On the average, *kok* has certainly the larger skull and the longer tooth row, but these are so like those of *gracilis* and the general form and measurements of the two animals are so similar, that it is impossible to regard them as being other than two forms of the one species.

A great deal of comparative work has yet to be done on the Indian and Ceylon mammals and I do not doubt that, when further comparisons are made among the mainland forms, the majority of the presently admitted species in the genus *Gunomys* will also be found to be but geographical races of one or more widely distributed species.

The oldest specific name available for the Indian long-tailed mole-rats appears to be *bengalensis*. This name was given by Gray to the Indian mole-rat in 1833, under the genus *Arvicola*, and it is very probable that the animal now known as *Gunomys kok*, also described by Gray in 1837 under the name *Mus kok*, is but a well marked race of that species. As, however, the necessary material is not available to me for the comparison of all the Indian forms, the name *Gunomys kok* must be retained for the present as the type species of the South Indian and Ceylon mole-rats. If it is proved that my suspicions are correct, i.e., that *kok* is but a race of *bengalensis* or some other species, then the specific name of the Ceylon form will require to be altered again.

The common Ceylon mole-rat, being now considered as a race of the mainland form *G. kok*, its name must for the present be—

### ***Gunomys kok gracilis* (Nehring)**

#### **The Common Ceylon Mole-rat**

*Nesokia hardwicki* and *Mus dubius* Kelaart, 1852. *Prod. Faun. Zeyl.*, p. 65

*Nesocia bengalensis* Blanford, 1891. *Faun. Brit. Ind.*, Mammalia No. 295 (partim)

*Nesokia gracilis* Nehring, 1902. *S. B. Geo. Nat. Fr. Berl.* p. 1

*Gunomys gracilis* Wroughton, 1908. *Jour. Bom. Nat. Hist. Soc.*, Vol. XVIII, p. 744

*Gunomys gracilis* Phillips, 1935. *Mammals of Ceylon* No. 82, p. 253

This form was originally described by Nehring in 1902 but no definite locality, other than 'Ceylon', was assigned to the type. It is assumed from the description, however, that it came either from the highlands or from the wet zone, south of Colombo. It represents a comparatively small race, with moderately short, somewhat coarse fur. The general colour of the upper parts is dark brown, grizzled with rufescent-grey, the shorter piles being dark grey tipped with pale rufescent-yellow and the longer piles, which predominate on the dorsal area, dark grey with dark brown tips; under fur dark grey; lower parts hoary-grey; feet dusky grey.

*Measurements* (average of seven males): length, head and body 187.4 mm.; tail 161 mm.; hind foot 34.3 mm.; ear 20.4 mm.; (average of eight females): length, head and body, 175 mm.; tail 143.5 mm.; hind foot 32.4 mm.; ear 18.7 mm.

Skull: greatest length 42.7 mm.; zygomatic breadth 24.5 mm.; brain-case breadth 16.5 mm.; interorbital breadth 6.6 mm.; upper molar series 7 mm. average of two females: greatest length 38.8 mm.; zygomatic breadth 22.6 mm.; brain-case breadth 16.7 mm.; interorbital breadth 6 mm.; upper molar series 6.5 mm.

*Remarks.* This race is found, in suitable localities, throughout the hills of the central mountain cluster, to altitudes of 5,000 feet. It is, however, more common at medium elevations and also in the south-western low-country wet zone, that is to say in the country contained in the Western Province, Province of Sabaragamuwa, and in the Southern Province, west of a line drawn from between Matara and Tangalla and northwards to near Balangoda. The rainfall varies in this area from about 80 to 200 inches, annually. It is commonly found in paddy fields and their vicinity.

The recently obtained specimens from the Jaffna Peninsula are considerably lighter in general colour and their fur is of different texture; they are, I consider, sufficiently distinct both from the common Ceylon form, *gracilis*, and from the mainland form, *kok*, to be regarded as being of a distinct race.

***Gunomys kok insularis*, sub-sp. nov.**

The Northern Ceylon Mole-rat

Size very much as in typical *kok*, but with a slightly smaller skull and tooth row. Mammae, in the type, in six pairs = 12.

*Fur.* Rather short, soft and sparse, with considerably fewer long piles on the dorsal area; that of the under parts short and scanty.

*Colour.* General colour of the upper parts, rufescent or sandy greyish-brown, the hairs being bluish-grey with rufescent or sandy-brown tips, intermixed with which, on the dorsal area, are a few longer piles with brown tips; under fur bluish-grey; lower parts light hoary- or whitish-grey; feet light grey.

In this race the long, dark piles of the dorsal area are far less numerous than in *gracilis* and, owing to their partial suppression, the general colour of the coat has a much lighter and brighter hue. From the race *kok*, it may be distinguished by its more distinct sandy hue, as well as by its smaller skull and tooth row.

*Measurements* of the type: length, head and body 186 mm.; tail 142 mm.; hind foot 34 mm.; ear 21 mm.

Skull: greatest length 40 mm.; zygomatic breadth 23.6 mm.; brain-case breadth 16.2 mm.; interorbital breadth 6 mm.; upper molar series 6.6 mm.

*Type.* An adult female, caught on March 9, 1935, at Thinney, near Jaffna, in the Northern Province of Ceylon. The type, together with a paratype adult male, has been deposited in the British Museum, by the Director, Colombo Museum.

*Remarks.* This race comes from a part of the Island with a very different climate to that of the habitat of *gracilis*. The Jaffna peninsula is very flat and low lying, the highest point being only some thirty feet above the sea level. The annual fall of rain is generally under fifty inches; by far the greater quantity falling during the months of October, November, and December, the wet season. During the remainder of the year the climate is hot and dry and the soil is sunbaked and parched where irrigation has not been resorted to.

It is scarcely surprising, therefore, that under these different climatic conditions a distinct race of *Gunomys* should have arisen. Indeed, Kelaart (1852) was aware of the fact that the Jaffna mole-rats were different to the common Ceylon form, for on page 66 (1852) he describes under the name *Nesokia kok* a stuffed specimen received from Point Pedro—the extreme northern point of the peninsula.

For purposes of comparison, the average measurements, in millimetres, of specimens of each of the three races that have been mentioned in this paper, are given below.

TABLE I.—*Body measurements of G. kok*

<i>Subspecies</i>	<i>Length Head &amp; body</i>	<i>Tail</i>	<i>Hind foot</i>	<i>Ear</i>
<i>G. kok gracilis</i>				
♂♂ (Average of two)	184	168	33.5	22.5
♀♀ (Average of four)	167.4	133	32	19.5
<i>G. kok insularis</i>				
♂♂ (Average of two young)	157	131	34	22
♀♀ (Average of two)	177	144.5	33.5	21
<i>G. kok kok</i>				
♂♂ (Average of three)	197.5	159	36.3	23

TABLE II.—Skull measurements of *G. kok*

<i>Subspecies</i>	<i>Greatest length</i>	<i>Zygom- atic breadth</i>	<i>Brain case- breadth</i>	<i>Inter- orbital breadth</i>	<i>Upper molar series</i>	<i>Remarks.</i>
<i>G. kok gracilis</i>						
♂ (one)	42.7	24.5	16.5	6.6	7	Teeth worn
♀♀ (Average of two)	38.8	22.6	16.7	6	6.5	do. do.
<i>G. kok insularis</i>						
♂ (one young)	37	22	16.2	5.5	6.5	Teeth unworn
♀♀ (Average of two)	39.6	23.6	16.1	5.8	6.5	Teeth slightly worn
<i>G. kok kok</i>						
♂♂ (Average of four)	41.2	25	16.4	6.2	7.6	Teeth worn

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## The Penis and its bone in Ceylonese Squirrels; with special reference to its taxonomic importance

BY

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(With Seven Text Figures)

The classification of the squirrels has always been a somewhat difficult problem. It was Thomas (1915) who first drew attention to the fact that the *os penis* or *baculum* as he termed it, had some value in assessing relationships in these rodents. Thomas noted that in many cases squirrels with a very similar appearance and outward form differed considerably in the nature of their bacula. Pocock (1923) elaborated Thomas's study of the bacula, corroborated his conclusions and made observations on the outward form of the glans penis. He pointed out that this too was subject to some extraordinary differences in form in squirrels that were otherwise difficult to distinguish. But the series of species examined by both Thomas and Pocock were by no means complete, and at present we are still in the dark as to which of the newly created genera some of the Ceylonese squirrels should be relegated. I have therefore, on the suggestion of Mr. W. W. A. Phillips, made a study of the penis and its bone in all the species of squirrels found in Ceylon. If the figures and descriptions given here are compared with those of Pocock it will be found that it is still almost impossible to assign some of the squirrels to a definite genus. Either too many genera have been instituted by Pocock, or too few, or thirdly his genera will have to be redefined in accordance with the statements recorded here.

As far as Ceylonese squirrels are concerned three genera of true squirrels have to be considered, besides the flying squirrels, which are now treated as a distinct family (Petauristidae). The three genera of true squirrels are *Tamiodes*, *Funambulus* and *Ratufa*. The two former were at one time considered under *Funambulus*, a name which included the palm-squirrels and the various jungle-squirrels. Pocock

separated *Tamiodes* on the penial characters mentioned below. *Ratufa* includes all the giant squirrels. Pocock's definitions of these three genera are as follows:—

*Tamiodes*—with a thick glans penis, with terminal labiate orifice; baculum large with its distal extremity bent upwards at a right angle to the rest of the shaft.

*Funambulus*—with glans terminally narrowed, a simple orifice on right side some distance behind tip; baculum large and gently curved upwards distally.

*Ratufa*—glans unknown; with relatively small baculum, curved as in *Funambulus*, but stouter and bevelled below distally.

There is no doubt about the apartness of *Ratufa* from the other two genera in the nature of its baculum. The structure of the glans further confirms this, as will be seen below. If Pocock's statements regarding the other two genera were correct, they too would be justifiably separable. As far as the Ceylonese animals are concerned, there are three types of glans penis besides that of *Ratufa*, and these are correlated with corresponding differences in the baculum. But none fits Pocock's definition of either *Tamiodes* or of *Funambulus* in its entirety. Further discussion must be left till the various forms have been described and figured. As scientific names cannot be used, the squirrels will be dealt with in groups under their English names, thus:—

- (a) The Palm-squirrels and Jungle-squirrels.
- (b) The Giant Squirrels.
- (c) The Flying Squirrels.

#### THE PALM-SQUIRRELS AND JUNGLE-SQUIRRELS

All these have hitherto been treated as species of the genus *Funambulus*. But Pocock pointed out that the species *striatus*, which Blanford (1888) had regarded merely as a variety of the palm-squirrel (*Funambulus palmarum*), differed so considerably from the latter in the nature of its penis that he instituted a new genus *Tamiodes* for its reception. Pocock did not examine the Ceylon races of *F. palmarum* or any of the other species found in this island. The question is, therefore, whether the insular forms of *palmarum* fall into line with the continental ones, and secondly whether the other species of striped squirrels are to be classed in the genus *Funambulus* or *Tamiodes*.

The palm-squirrel is represented in Ceylon by four named races (*favonicus*, *olympius*, *kelaarti* and *brodiei*). I have examined the penis and baculum in the first and last of these. Of jungle-squirrels, two species are recognized (*layardi* and *sublineatus*) the former by two races (*layardi* and *signatus*) and the latter by one (*obscurus*).

All the above possess a very large penis relative to the size of the animal. It is disposed in a peculiar asymmetrical manner. From the symphysis pubis the body of the organ passes forwards almost half way along the ventral belly wall in the mid-line. It then takes a sharp turn caudally and somewhat to the right running ventral to the proximal portion. About half-way on its recurrent course it enters the prepuce, the orifice of which opens backwards. By withdrawing the prepuce, the glans penis can be seen as a subcylindrical object with a more or less swollen terminal portion, often sculptured in a complex manner. Behind this, the glans narrows towards the main part of the shaft, this part being simple in structure. The invaginated layer of the prepuce is attached to the hinder margin of this at a level just distal to the sharp kink mentioned above. The urethra runs along the body of the penis on its ventral aspect in a narrow corpus spongiosum. In the glans it runs asymmetrically, grooving the baculum on the right and opening on the right aspect of the glans generally some distance behind the summit. It is to be noted that the morphological aspects of the glans are reversed on account of the bend on the penis. The dorsum of the glans comes to lie ventrally and its venter dorsally. The baculum lies in the glans and therefore suffers the same change in morphological relations. It is elongated, with a narrow shaft, a thickened base and an apex which tends to bifurcation. The (morphologically) dorsal limb of the bifurcation becomes very superficial and forms a palpable prominence near the summit of the glans. The urethral orifice is to the right and below this prominence. Further details of the glans and baculum differ so much, in the different forms examined, that it will be necessary to describe each under its own heading.

### 1. The Palm-squirrel (? *Funambulus palmarum*)

Of the Ceylonese races of this species, I have examined the penis and baculum in the wet-zone *favonicus* and the dry-zone *brodiei*. They are both very much the same as regards their external genitalia, and may therefore be treated together. They differ, however, from Pocock's descriptions and figures of *palmarum*, which were, presumably, based on Indian material.

TABLE I.—Penis measurements in *F. palmarum*

Subspecies	L. of glans (tip-corona)	Trans. diam. of glans	Dorso- vent. diam. of gl.	L. of baculum
	mm.	mm.	mm.	mm.
<i>javonicus</i>	12	6	7	12.5
<i>brodiei</i>	13	5	7	12.0

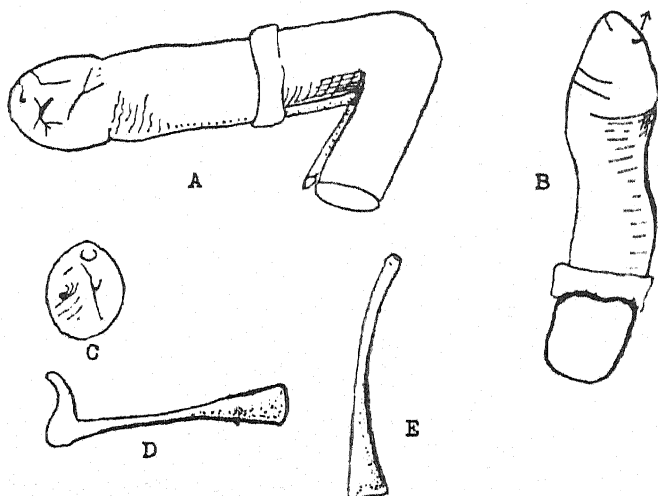


Fig. 1. The penis and baculum in the Wet-zone Palm-squirrel (subspecies *javonicus*). A. Body and glans of penis from the left. B. Ditto from the dorsal aspect (arrow indicates meatus urinarius). C. Apical view of glans. D. Baculum from the left. E. Baculum from the dorsal aspect.

#### *Glans penis*

The glans penis in both forms consists of a proximal smooth cylindrical portion and an apical more globular part. The two parts are separated by a faintly constricted neck, which in *brodiei* is better seen on account of a deposit of melanin pigment ventrally and at the sides.

The globular portion is truncated distally, but more so from the right than the left, so that, when viewed from above or below, the left upper portion of the apex forms a rounded summit caused by the presence of the tip of the baculum under the mucosa. The meatus urinarius is situated to the right and below this prominence, and lies

within one of the cleft-like fissures into which this part of the glans is sculptured. In *favonicus* there are four or five small fissures below the meatus passing obliquely from above and to the left downwards and to the right. Another deeper fissure lies at the bases of these and at right angles to them. Other small fissures are seen further back, especially on the left side. Fissuration is less evident on the glans of *brodiei*.

The above description differs from that given by Pocock of *palmarum*. He describes a narrow attenuated process at the termination of the glans and rising upwards from its spongy globular portion.

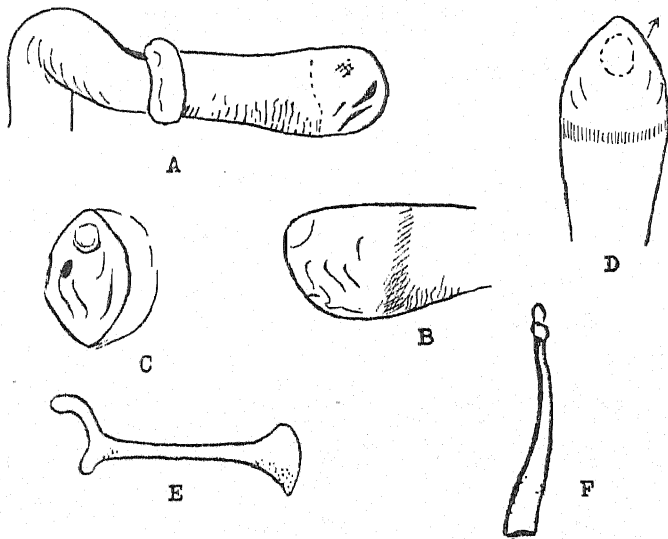


Fig. 2. The penis and baculum in the Dry-zone Palm-squirrel (subspecies *brodiei*). A. Body and glans of penis from the right. B. Glans from the left. C. Apical view of glans. D. Glans from above. E. Baculum from the left. F. Baculum from below.

### *Baculum*

The baculum in *favonicus* and *brodiei* is an attenuated slightly curved rod, flattened laterally. In both forms it ends in a bifurcated manner, but the exact form of the end is slightly different in the two races. In *favonicus* the lower limb of the fork is just the enlarged distal end of the shaft. The upper limb, which may form a separate ossicle, is a pointed process responsible for the prominence already mentioned at the tip of the glans.

In *brodiei* the baculum is more distinctly bifid at the tip. The lower limb of the bifurcation is short and rounded. The upper is narrow, long and hooked at the tip, the dorsum of the hook being responsible for the superficial prominence of the glans. The shaft of the baculum in both races is markedly asymmetrical when viewed from above or below. It is concave on the right where it lodges the urethra, and convex on the left.

Pocock distinctly states that the baculum of *Funambulus* is a simple rod, curved with a concavity dorsally and ending in a single pointed tip. He gives one of the characters of *Tamiodes* as the upturning of the tip of the baculum at right angles to the shaft, and his figures of the bone in *T. striatus* closely resemble those given here of *brodiei*.

## 2. Layard's Jungle-squirrel

Under this heading I shall describe the genitalia of the typical Layard's Squirrel and of its lowland modification *signatus*, the Flame-striped Jungle-squirrel. The former is confined to the hills of Central Ceylon; and the latter to the wet south-western lowlands.

TABLE II.—*Penis measurements in F. layardi*

<i>Subspecies</i>	<i>L. of glans</i> mm.	<i>Trans. diam. of glans</i> mm.	<i>Dorso- vent. diam. of gl.</i> mm.	<i>L. of baculum</i> mm.
<i>layardi</i>	11.5	6	6	11
<i>signatus</i>	9	4.5	5	10.5

From this table, the penis will be gathered to be somewhat smaller than in the palm-squirrels, that of *signatus* being the smallest of all.

### *Glans penis*

The penis and its glans have the same general relations as in the palm-squirrels, but the detailed structure of the glans is different. The general shape of the glans is, in both races of *layardi*, more pyriform, with the broad end distally. There is no demarcation between the proximal and distal parts of the glans. The outline of the dorsum is almost straight, but the ventral outline is markedly bulged some distance from the apex. The apex is surmounted by a conical projection, better marked in typical *layardi*, which points

slightly to the right. The projection and the glans behind it is sculptured by numerous fissures, and these are longer, deeper and more complicated than in *palmarum*. The meatus urinarius is situated between the fissures in the same position as in *palmarum*.

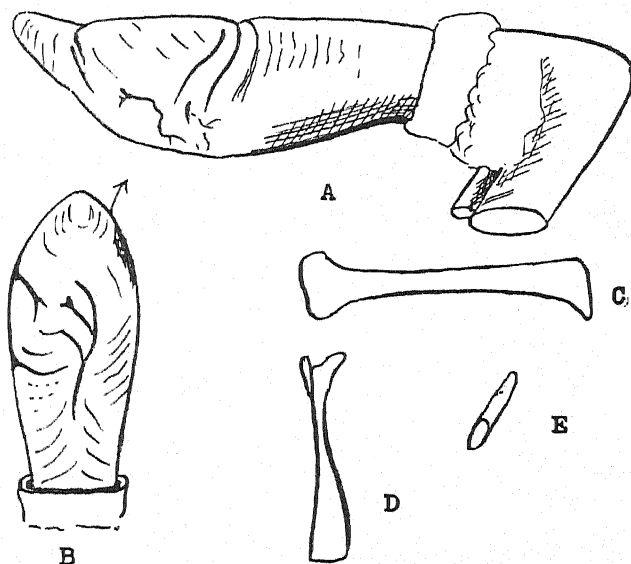


Fig. 3. The penis and baculum in Layard's Jungle-squirrel (subspecies *layardi*). A. Body and glans of penis from the left. B. Glans from above. C. Baculum from the left. D. The same from above. E. End-on view of baculum.

### *Baculum*

The baculum in both these races is simpler than in *palmarum*. The shaft is stouter and shorter, but shows a tendency to bifurcation, though there is less difference between the two limbs of the bifurcation. In typical *layardi*, the bifurcation is only visible from above or from the distal end. The two components are small, laterally flattened and arranged asymmetrically, with a concavity lodging the urethra lying above and to the right. The shaft is curved and grooved as in *palmarum*. In *signatus* the bifurcated arrangement can be seen



to some extent in side-view, which shows the upper element to be sharply pointed, and the lower one to be blunt. The urethra has the same relations as in typical *layardi*.

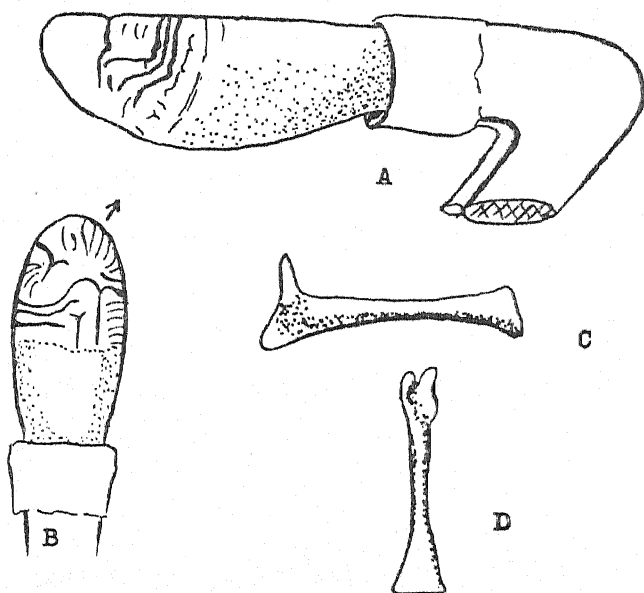


Fig. 4. The penis and baculum in the Flame-striped Jungle-squirrel (subspecies *signatus*). A. Body and glans of penis from the left. B. Glans from above. C. Baculum from the left. D. The same from above.

### 3. The Dusky-striped Jungle-squirrel

This squirrel is represented by a single race (*obscurus*) the typical race (*sublineatus*) being confined to Travancore and the Nilgiris. According to Phillips (1928), this animal is in general appearance and habits more like *layardi* than *palmarum*. The condition of the penis and its bone cannot be said to support this view, for it presents a general form more like that of *palmarum*, though in details different from both.

*Measurements*

This is the smallest of the striped squirrels in Ceylon, and the following measurements indicate that its penis follows this rule also.

TABLE III.—*Penis measurements in F. sublineatus*

<i>Subspecies</i>	<i>L. of glans</i> mm.	<i>Trans.</i> <i>diam.</i> <i>of glans.</i> mm.	<i>Dorso-</i> <i>vent.</i> <i>diam.</i> <i>of gl.</i> mm.	<i>L. of</i> <i>baculum</i> mm.
<i>obscurus</i>	6	2.5	4	7.5

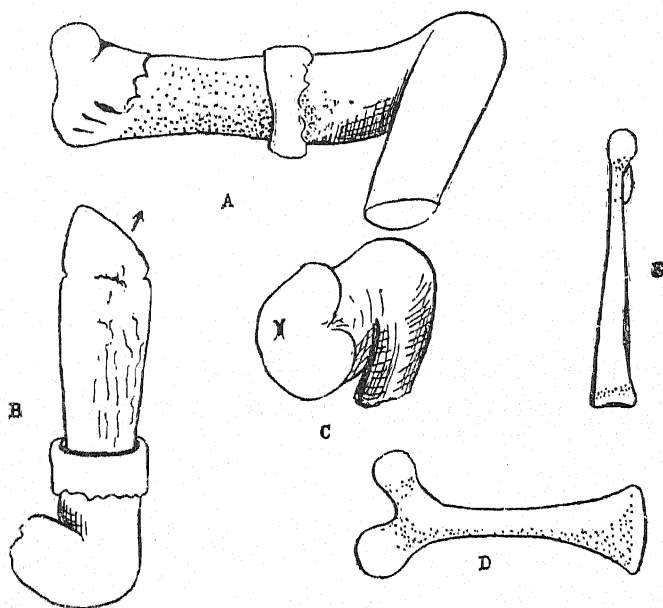


Fig. 5. The penis and baculum in the Ceylonese Dusky-striped Jungle-squirrel (subspecies *obscurus*). A. Body and glans of penis from the left. B. Same from above. C. Apical view of glans. D. Baculum from the left. E. The same from above.

*Glans penis*

The glans consists, as in *palmarum*, of two portions; a distal and proximal, separated by a slight notch at the sides, and by an irregularly fluted groove dorsally. There is no sharp demarcation ventrally. The proximal portion is long, cylindrical and smooth. The distal part is

also smooth for the main part, but shows two or three small horizontal fissures on the left. The glans is obliquely truncated distally. In side view, it appears to end in two swollen knobs, one dorsally and one ventrally, separated by a slight concavity. The apical view indicates that these knobs are better marked on the left, where they are separated by a deep notch. To the right of the notch is the opening of the urethra, which is distinctly labiated, the lips being disposed left and right. The two terminal knobs are caused by the underlying baculum.

*Baculum.* The bone is large relative to the size of the glans. Its shaft is similar to that in *palmarum*, but relatively stouter. It terminates in two swollen knobs separated by a deep depression. The knobs are rounded, and the ventral knob is larger than the dorsal, thus differing from all the bacula described above.

## THE GIANT SQUIRRELS

### Genus *Ratufa*

The glans penis has not been described in any species of *Ratufa*. The baculum has been described and figured by Pocock in the Indian *R. gigantea* and *R. fellii*, as well as in a captive specimen of *R. indica*. Dammerman (1931) has similarly dealt with the Malayan *R. bicolor*. The data given below relate to the species *R. macroura* which is confined to Ceylon, where it is represented by four named races, three of which at any rate are very distinct from one another. The only race examined in the present connexion is the common dry-zone form, *R. m. sinhala*, the others being very difficult to obtain.

### Measurements

The penis in *Ratufa macroura* is built on the same plan as in the former genera, but relative to the size of the animal is much smaller, as indicated by the following measurements;—

TABLE IV.—*Penis measurements in Ratufa*

<i>Species</i>	<i>L. of glans</i> mm.	<i>Trans. diam. of glans</i> mm.	<i>Dorso- vent. diam. of gl.</i> mm.	<i>L. of baculum</i> mm.
<i>R. m. sinhala</i>	33	7	8.5	11
<i>R. bicolor</i> (Dammerman)	—	—	—	(without hook) 9.4 to 9.9

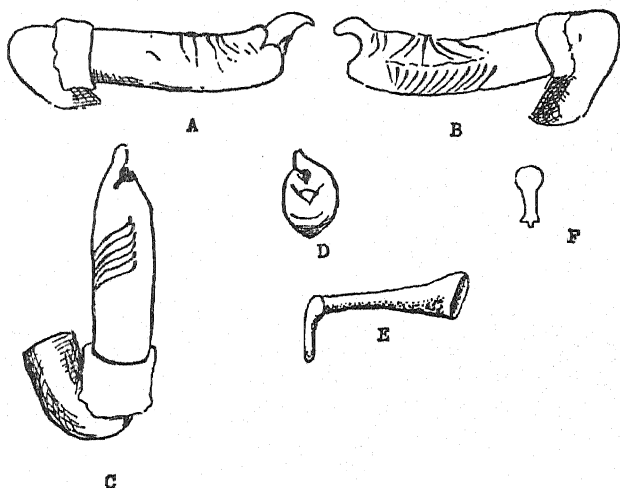


Fig. 6. The penis and baculum in the Dry-zone Long-tailed Giant Squirrel (*Ratufa macroura sinhala*). A. Glans from the right. B. The same from the left. C. Body and glans of penis from below. D. Apical view of glans. E. Baculum from the left. F. Apical view of baculum.

#### *Glans penis*

The glans in *R. m. sinhala* is a long laterally-compressed cylindrical structure, straight when viewed from above or below, but slightly curved with an upward concavity, when viewed from the side. The proximal part is covered with smooth mucous membrane, which is thrown into certain permanent folds or flutings on particular regions. Dorsally there are half a dozen such folds. These spread transversely and on the right, pass forwards and fade away half way down the right lateral surface, the rest of which is smooth. On the left, they also pass half way down the lateral surface, but only the first two pass forwards, the remainder being either vertical or passing backwards. On the left aspect the folds are met by about a dozen similar folds sweeping upwards and backwards from the ventral margin. The line of meeting of the two sets of folds is marked by a longitudinal fluted band (Fig. 6, B).

The glans terminates distally in a hook. This is situated dorsally and to the left, and arches over with its concavity ventrally. Below and to the right of the base of the hook, is the opening of the meatus urinarius, guarded by three lips, two ventral and one dorsal (Fig. 6, D).

*Baculum*

In *Ratufa gigantea*, *R. felleri* and *R. bicolor*, the authors mentioned above found the baculum to be a simple rod-like structure slightly curved with the concavity dorsally. The rod is described by Pocock as similar to that which he found in his examples of *Funambulus palmarum*, but shorter and stouter. Dammerman shows the basal end to be expanded and hollowed in *bicolor*, and the apex to be narrowed and flattened horizontally.

In *R. macroura* I find the bone to be short and stout, and its shaft to be shaped as described and figured by Dammerman in *bicolor*. The distal extremity, however, is very different. It is surmounted by a strong downwardly directed hook, 6 mm. long, placed at an angle of 90° with the shaft. The base of the hook near its attachment to the shaft is expanded somewhat laterally. Thereafter it narrows till near the tip, where it again expands to end in a flattened trifoliate plate (Fig. 6, F).

## THE FLYING SQUIRRELS

Two species of flying squirrel occur in Ceylon. The larger, *Petaurista philippensis lanka* is comparatively common, and I have had the opportunity of examining the genitalia of several males. The other, *Pteromys (Petinomys) layardi* is very rare. Only two skins are found in the Colombo Museum collection, and in these the genitalia are missing. One living specimen owned by Dr. L. Nicholls has been accessible for examination but this was found to be immature, and the penis not capable of being protruded through the foreskin. The penis could be felt under the skin of the abdominal wall and had the same general shape as in the other squirrels, but further details must await the demise of this valuable specimen.

## The Large Grey Flying-squirrel

*Petaurista philippensis lanka*.

The penis in this species has the same basal conformation as in other squirrels. In size it is relatively larger than in *Ratufa*, being equal in this respect to that of the striped squirrels. The baculum occupies a greater relative length of the glans, and appears to be fairly uniform in characters in different species of the genus, judging from the figures of Pocock and Dammerman.

TABLE V.—*Penis measurements in Petaurista*

<i>Subspecies</i>	<i>L. of glans</i> mm.	<i>Trans.</i> <i>diam.</i> <i>of glans</i> mm.	<i>Dorso-</i> <i>vent.</i> <i>diam.</i> <i>of gl.</i> mm.	<i>L. of</i> <i>baculum</i> mm.
<i>lanka</i>	23	6	9	19

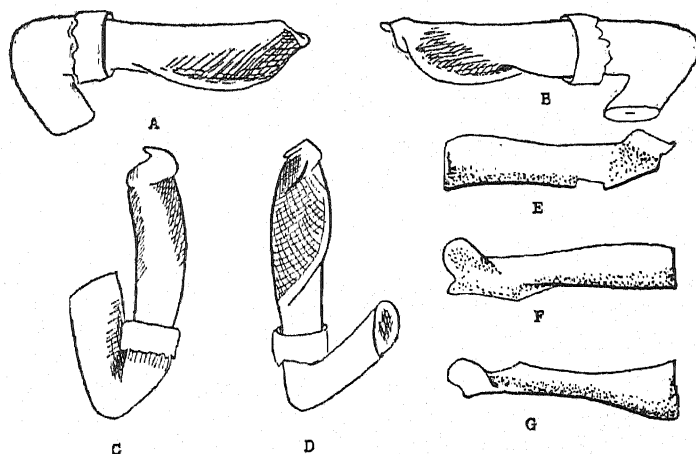


Fig. 7. The penis and baculum of the Flying-squirrel (*Petaurista philippensis lanka*). A. Body and glans of penis from the right. B. The same from the left. C. The same from above. D. The same from below. E. Baculum from the right. F. The same from the left. G. The same from above.

### *Glans penis*

The glans has not been described in any flying-squirrel, so that the following account may be taken as a standard of comparison for future workers.

The striking fact about the glans in *P. p. lanka* is the spiral twist upon it. This is not actually a twist on the axis of the organ, but an appearance due to two spiral bands which stand out from its surface. The larger of the two bands commences proximally near the attachment of the inverted layer of the foreskin and slightly to the right side

and ventrally. It proceeds ventrally and to the left, gradually becoming more prominent, and then takes a sharp dorsal sweep to end on the left near the tip of the glans just below the dorsal border, which is here slightly raised. A few millimetres prior to its termination the second, smaller, but more twisted band commences somewhat to the right of the main band, and separated from the latter by a groove. This second lamina follows the same type of course as the previous one, but has a greater spiral twist. It takes about one and a half turns in the clockwise direction and ends at the summit of the glans with an S-shaped final twist. This second band is the cause of the raising of the terminal portion of the dorsal border. The meatus urinarius is situated below and to the right of the final S of the second spiral band, within a deep fissure, whose axis follows the course of the ventral part of the first spiral band, which ends distally in line with the terminus of the second spiral band. No other fissures or markings occur anywhere on the glans.

### *Baculum*

The baculum has been described and figured by Pocock in Indian specimens of *P. philippensis*, and in another unidentified species, and by Dammerman in *P. petaurista*. The last named agrees well with Pocock's examples of *P. philippensis*, and also with my own observations on the Ceylonese race of that species. Pocock's other species had a different baculum, but that need not concern us here.

The details of the baculum can only be understood when compared with the glans penis as above described. The baculum has a simple smooth shaft, with a concavity at the proximal end. Distally it presents certain features due to ridges of bone which serve as supports for the spiral bands mentioned above. The distal part of the ventral margin of the bone is surmounted by a sharp ridge, which passes from behind forwards and to the right, and supports the most prominent part of the ventral convexity of the first spiral band. It is marked off from the rest of the shaft, posteriorly, by an angular notch. To the left and above the ridge is a broad, shallow groove which lodges the urethra. The second spiral band is supported by another ridge situated on the dorsal border nearer to the tip, and having the same course and direction as the band which it supports. It has a sharp posterior margin behind which the dorsal contour of the bone dips down to form a concavity separating the ridge from the main part of the shaft. This sharp demarcation would appear to be still more marked in *P. petaurista*, and in Pocock's Indian example of *P. philippensis*.

## DISCUSSION

The above results indicate that the flying-squirrels have a totally different type of penis from the true squirrels, and probably agree among themselves fairly closely in the main features of the organ. *Ratufa* would appear to be very different from the smaller squirrels in its penial characters, but there is apparently less uniformity through the genus than would have been expected. The differences of *R. macroura* from the other types cannot, at this stage, however, be granted to be of generic importance, though differences of similar order have been used by Pocock in separating some of the smaller squirrels generically.

The striped squirrels, on the contrary, form a very difficult problem. According to Pocock's definitions the Ceylonese races of *palmarum* would fall into the genus *Tamiodes*, whilst *layardi*, with its conical appendage on the tip of the glans, would fall into *Funambulus*. Probably *sublineatus* on the characters of its glans would fall between the two; though, on its baculum, it would require a new genus. It seems almost absurd that different geographical races, of what would otherwise be regarded as one and the same species, should on the their penial characters require separate genera, though theoretically one is bound to admit that this is the correct procedure. Until more species have been examined in this connexion, I consider that it is best to retain *Funambulus* for all these striped squirrels, despite their penial differences. The alternative is to redefine the genera *Tamiodes* and *Funambulus* to fit the new knowledge, and, probably in addition, to institute a third genus for *sublineatus*.

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## Supplementary Observations on Purple-faced Leaf-monkeys (Genus *Kasi*)

BY

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(With One Plate)

The following supplementary notes to my monograph (1934) on the purple-faced leaf-monkeys become necessary for the following reasons. Pocock (1935) has made an important contribution dealing with leaf-monkeys found to the east of the Bay of Bengal, and goes into some detail concerning the structure of those forms which he previously (1928) had relegated to the *Pyrrhus*-group, to which group I considered the purple-faced monkeys more closely allied than to the *Entelloids* (Pocock's *Entellus*-group). Pocock has gone a step further and proclaimed all his three groups of leaf-monkeys as full genera, and hints that the Ceylonese forms may require generic separation later. He was apparently unaware of my treatment of them as a distinct sub-genus. During my leave in England in 1934 I had the opportunity of examining all the material in the British Museum (Natural History) germane to the question. Since my return to Ceylon I have examined the material here in the light of Pocock's recent observations, and have also been fortunate in obtaining ample fresh material of the little known form *philbricki*.

### TAXONOMIC NOTES

It is to be regretted that in this paper the monkeys dealt with have to be referred to by different names from those used in the previous monograph. This seems to be the usual procedure almost, but becomes necessary as a result of the progress of knowledge. Apparently the generic name *Pithecus*, which Thomas (1916) had suggested for all the leaf-monkeys after separation of the Chinese forms known as *doucs*, has been suppressed by the International Commission on Zoological Nomenclature (Opinion 114, 1929) (see G. S. Miller, 1933, and also Zuckerman and Fulton, 1934). To replace it, G. S. Miller (1934) uses

*Presbytis* Eschscholtz for the generic name. By splitting this genus into three, Pocock (1935) restricts *Presbytis* to the group which he had previously called the *Aygula*-group, and reintroduces *Trachypithecus* Reichenbach for the *Pyrrhus*-group. He is apparently uncertain what to call the Entelloids, but wishes to be rid of *Pithecus* and go back to *Semnopithecus*. This can be done if the Ceylonese forms are separated from the Entelloids, as indeed they should be, as indicated in my monograph. The question is then what to call the purple-faced monkeys if they are to be treated as a separate genus or subgenus. The belief that *Pithecus* had its genotype in Linnaeus's *veter* is due to Thomas, who at one time maintained this to be an indeterminable species but later decided that it was a Ceylonese animal. There is a very great deal of doubt about this *veter*. Linnaeus based it on a monkey from Ceylon described by Ray (1693) as having a long black beard. No monkey with this description lives in Ceylon, or elsewhere in Asia, so that *veter* and *Pithecus* are best discarded once and for all. The next available name for the purple-faced monkeys, if they are to be separated from the rest of the leaf-monkeys, is *Kasi*, originally founded by Reichenbach (1862) for the Malabar form then known as *Semnopithecus johnei* or *S. cucullatus*, and which therefore becomes the type of the new genus. Accordingly I propose to treat *johnei* as a full species, and all the Ceylonese forms as a second species of *Kasi*.

With the promotion of the subgenera of leaf-monkeys to full genera it seems desirable to promote the sub-family Colobinae to family rank,<sup>1</sup> and to institute two new sub-families, one for the African forms, and another for the Oriental ones, thus;—

Family Colobidae—Old-World monkeys without cheek-pouches

Sub-family A—COLOBINAE (AFRICAN COLOBIDAE)

One genus only,—*Colobus*

Sub-family B—PRESBYTINAE (ASIATIC COLOBIDAE)

Genera;—*Presbytis*—Mitred Leaf-monkey, etc.

*Semnopithecus*—Entelloid Leaf-monkeys (Langurs s.s.)

*Kasi*—Purple-faced Leaf-monkeys (Wanderoos s.s.)

*Trachypithecus*—Negro Leaf-monkey, etc. (Lutongs)

*Pygathrix*—Doucs

*Simias*

*Rhinopithecus* } Snub-nosed monkeys

*Presbytiscus* }

*Nasalis*—Proboscis monkey

<sup>1</sup> Pocock (1925) has already done this on other grounds.

### Family Colobidae

The characters of this family are those of the sub-family Colobinae of the Cercopithecidae of Blyth and most subsequent authors. The main points may be summarized thus;—

General form slender; limbs long and slender, hind-limb longer than fore-limb; hands and feet very elongated with thumb rudimentary or absent; tail always long; hairs without annulations, though sometimes frosted at the tips in some parts of the body; cheek-pouches absent; salivary glands and glands on posterior third of tongue hypertrophied; stomach sacculated; liver flattened and confined to right hypochondrium.

Osteologically the characterization is thus;—

Skull with frontal region rounded and facial angle high; ascending ramus of mandible high and broad antero-posteriorly; lower third molars with five cusps (except in *Presbytis femoralis*); caudal vertebrae very elongated and with chevron bones on the anterior ones; sternum very narrow; centrale present in carpus.

#### Sub-family PRESBYTINAE

This group includes all the Asiatic Colobidae. These were formerly considered as forming a single genus variously labelled *Presbytis*, *Semnopithecus*, *Pygathrix* or *Pithecus* by different authors. The proboscis and snub-nosed monkeys were early split off from the main genus. Later the doucs (*Pygathrix*) were removed by Thomas. Now Pocock divides the remainder into three separate genera; rightly because they present definite structural differences. Herein the purple-faced monkeys are split off from alliance with the Entelloids wherewith Pocock had left them. Mivart (1875) used *Semnopithecus* for all the Asiatic monkeys without cheek-pouches and characterized them merely as having a small thumb, and so distinguishing them from the African *Colobus* which has no thumb. It is now necessary to define them more particularly as follows;—

Body less heavily built than in Colobinae; limbs relatively longer and more slender; thumb present; pelage generally soft and silky, often with long hairs, but never with localized mane-like growths; hairs sometimes bicolored, though never annulated; callosities moderate; nasal septum narrower.

The skull characters are variable from genus to genus, whilst those of the Colobinae are tolerably uniform (Schwarz, 1923). As a general rule the Presbytine skull is rounded and the brow-ridges but little

developed, except in the genus *Semnopithecus*. The orbits are large and squarish, with prominent margins. The interorbital septum is relatively broad. The apertura pyriformis extends often half way up the interorbital region.

Genus **Kasi** Reichenbach, 1862

Purple-faced Leaf-monkeys

*Presbypithecus* Trouessart, 1879. *Rev. Mag. Zool.*, p. 57. Elliot, 1913. *Monogr.*, III, p. 68

*Pithecus* Hill, 1934. *Ceylon J. Sci.* (B) XIX, p. 30

This genus of Presbytinae includes the purple-faced leaf-monkeys only. They are restricted in habitat to Ceylon and the Malabar tract of southern India. They were included by Pocock (1928) in the *Entellus*-group (since generically separated as *Semnopithecus*). I have shown them (1934) to be more closely related to the Malayan *Pyrrhus*-group (*i.e.*, genus *Trachypithecus*) than to the *Entelloids*, and have accordingly treated them as a separate group and have given them subgeneric rank. If, however, the other groups are to have the status of full genera, then the purple-faced monkeys must also be thus treated. The characters of the genus are therefore those formerly given for the subgenus *Pithecus*. Further study has shown additional reasons for separating these monkeys from alliance with the *Entelloids* and placing them closer to the genus *Trachypithecus*.

The characterization of the genus *Kasi* is as follows:—

Heavily-built leaf-monkeys with glossy coat of dark colour in the adult on both dorsal and ventral aspects; new-born with a very light silvery-grey coat (except in *K. johni*, in which it is black); skin heavily-pigmented in adult, especially on the naked parts, which are dark purplish-black, unpigmented in the new-born; hair on crown paler, semi-erect and cranio-caudad in direction and never any crest or whorl formation; a patch of short hair on the sacral region, often paler than the rest of the back; a patch of white hair on the pubic region in the female; glans penis with an entire corona glandis; vulva as in *Trachypithecus*.

*Comparison between Kasi and related genera.*

A number of structural peculiarities of the related genera *Kasi*, *Semnopithecus* and *Trachypithecus* need some further treatment. The points concerned were either not touched upon at all in the previous monograph, or were only mentioned briefly.

### Hair

The character of the hair differs considerably in *Semnopithecus* from that of *Kasi* or *Trachypithecus*. For the purpose of this study, a sample of hair was removed from a given region (mid-dorsal region) of the different types of *Kasi*, and of a number of other monkeys, representing the other two genera. In all forms of *Kasi* the hair is fine, silky in texture, and slightly wavy. The length varies in the different geographical races. Microscopically the hairs show a fine surface-imbrication and pigment is scattered in granular form through the cortex of the greater part of the hair. In places the granules run together to form longitudinally placed spindle-shaped agglomerations. The terminal portion of the hair is without pigment in most forms. The medulla is peculiar in being composed of heavily pigmented disc-shaped masses placed face to face along the length of the hair. Here and there these masses are absent, but the discrepancies vary with the race of monkey. Medulla is always absent from the terminal part of the hair.

The hair of *Trachypithecus* closely resembles that of *Kasi* and has the same fine texture, but pigment is restricted to the cortex. The medulla is invisible without special treatment.

In *Semnopithecus* the hair differs greatly from that of the two genera mentioned above. It is coarser and longer and has a different microscopical structure. Each hair is 30 to 50 per cent. thicker than the corresponding hairs in *Kasi*. The surface imbrications are coarser. Pigment is lightly developed in both cortex and medulla. In the cortex it is in the form of very fine scattered granules. In the medulla it forms solid black masses with considerable intervals of non-pigmented medulla between them.

### External nose

The general physiognomy of the living *Kasi* is very different from that of *Semnopithecus*, but the difference is difficult to put into words. It is due mainly to the presence of well-developed supraorbital ridges in *Semnopithecus*, these being absent or poorly developed in *Kasi*. Another factor is the arrangement of the whiskers, which are bushy and laterally elongated in *Kasi* and shorter and downwardly directed in *Semnopithecus*. The effect is that the naked part of the face is triangular in *Semnopithecus*, with the base at the supraorbital ridges and the apex at the chin. In *Kasi* the face is rounder or trifoliate, with a couple of circular areas in the orbital regions and a third forming the muzzle. Details of the physiognomy depend on the shape of the external nose, and the form and size of the lips, including the way they are held during life.

In the external nose the bridge is more convex from side to side in *Semnopithecus* than in *Kasi* where the bridge is flatter and more depressed. The distal part of the nose, supported by cartilage only, is more variable. Accurate measurements reveal many individual variations in this part of the nose, but little in the way of constant generic or specific distinctions. On the whole the external nares are more patent in *Kasi* and the lateral margin forms a lip or rim not present in *Semnopithecus*. In both forms there is a wide, expanded portion of the internarial septum above and a narrow portion below. In *Kasi* the centre of the wide portion is more depressed. There is no constant difference in the angle formed by the long axes of the narial openings, individual variations being great and overlapping in the two genera. The average for five specimens of *Semnopithecus* was  $63.1^{\circ}$  and for eight of *Kasi*  $64^{\circ}$ . Individual angles in *Kasi* vary from  $54^{\circ}$  to  $79^{\circ}$ , and in *Semnopithecus* from  $52^{\circ}$  to  $70^{\circ}$ .

### *Tongue*

The tongue of *Kasi* has been described in great detail by Sonntag (1921) under the title of *Presbytes cephalopterus*. I have confirmed most of the points in his description, but I do not find that the apex of the organ is as square as indicated in his figures, nor have I noted the secondary papillae at the anterior poles of the circumvallate papillae. The main points to be noted in the tongue of *Kasi* are: (i) spatulate apex, (ii) three prominent circular circumvallate papillae forming an isosceles triangle with the apex behind<sup>1</sup>, (iii) fungiform papillae form a zone bounding the margins of the tongue and are absent from the centre of the dorsum, (iv) lateral organs prominent and extend on to inferior surface, (v) frenal lamella triangular with a bifid apex, (vi) glands on posterior third of tongue very numerous and large giving a thick mucous secretion to the surface of the tongue, often present even in long-preserved specimens.

Sonntag notes that in *Semnopithecus c. entellus* the tongue is thicker, circumvallate papillae are smaller and with a more nodulated posterior vallum, fungiform papillae are more numerous, and conical papillae are more numerous on the base. In *S. c. priamus* (Madras Langur) he describes the frenal lamella as triangular and bifid, and the apical circumvallate papilla as smaller than the others. In the capped leaf-monkey (*Trachypithecus pileatus*) the frenal lamella is a broad bilobed plate.

<sup>1</sup> I found a fourth rudimentary circumvallate papilla between the anterior pair in one young specimen of *K. vetulus nestor*,

My own observations on the tongue of *Semnopithecus entellus thersites* do not entirely agree with those of Sonntag on *S. e. entellus*. The tongue is not appreciably thicker than in *Kasi*, but is more inclined to be squared at the apex. The anterior circumvallate papillae are distinctly more prominent, and the vallum deeper. The posterior papilla is rudimentary as in Sonntag's *S. priamus*. Fungiform papillae are slightly more numerous, and the conical papillae coarser towards the base. The lateral organs do not extend so far on to the inferior aspect of the tongue. The frenal lamella is denticulated along each margin, and has two large apical denticles placed in apposition so as to appear triangular. In *Kasi* the apical denticles are separated by a space of variable width, whilst the lateral margins are smooth.

On the whole the tongue in *Kasi* is more like that of *Trachypithecus* than of *Semnopithecus*.

### *Laryngeal Sac*

The laryngeal diverticulum is a prominent feature in all Presbytinae. In *Kasi* it is a thin-walled subcutaneous sac covering the entire front of the neck, extending laterally as a pair of recesses into the posterior triangle, and inferiorly for some distance beyond the clavicles. Dorsally the sac is related to the infrahyoid muscles, larynx, trachea and thyroid gland, and, more laterally, with the sternomastoids and with the structures in the posterior triangle. The sac communicates with the interior of the larynx by paired openings situated in the thyrohyoid membrane. The openings have a valvular mechanism contributed to by the hyoid bone and the sternohyoid muscle. The wall of the sac is as thin as tissue-paper and is separated from neighbouring tissues by delicate areolar tissue only. In *Semnopithecus entellus thersites* the sac is similar but more extensive. It reaches from the chin to the front of the chest and extends laterally as far as the acromion.

### *Anal region* (Plate II)

The anus, as in other leaf-monkeys is, in *Kasi*, situated on a prominence. The region between the anus and the base of tail is depressed. The surrounding naked skin was discussed in my earlier monograph.

The callosities are very variable. I have studied the angles formed by the long axes of the callosities as done by de Beaux (1923) in his studies on the macaques. The callosities vary so much in the shape of their outline that the long axis is in a different position in almost every specimen. Thus in a series of *K. vetulus philbricki* two specimens, one male and one female, had a callosity angle of 69° and a third



(female) one of  $45^{\circ}$ . Two female *Semnopithecus e. thersites* had angles of  $38^{\circ}$  and  $67^{\circ}$  respectively. The inference is drawn, therefore, that the callosities have no constant sexual, subspecific or specific features.

#### *Female genitalia* (Plate II)

Pocock (1935) has studied the vulva in a large series of leaf-monkeys and has arrived at the conclusion that differences of structure occur supporting his division of the group into the three genera *Presbytis*, *Trachypithecus* and *Semnopithecus*. Apparently the most distinct and specialized condition of the vulva occurs in *Presbytis*, in which the clitoris lies outside the labia in a separate and prominent sheath of its own. *Trachypithecus* has a more usual vulva with lateral lips enclosing the clitoris as well as the urethral and vaginal openings. On the basis of a single specimen of *Semnopithecus* figured in an earlier paper (1925), Pocock states that in this genus the vulva resembles that of *Presbytis* rather than that of *Trachypithecus*. The condition in *Kasi* is not referred to, although mention of the vulva in a young *vetulus* (under the name *Pithecus cephalopterus*) is made in his earlier paper.

In discussing this topic, it is important to bear in mind the variations occurring as a result of pregnancy and parturition. It is essential, therefore, that statements should be based on observation of as many individuals as possible. Live animals or fresh cadavera are far more useful than preserved and hardened material. My own observations are based on all these types of material and include specimens of all ages.

With these provisos, it may definitely be stated that in all forms of *Kasi* the vulva agrees with that of *Trachypithecus*. It is a small slit-like vulva with lateral lips enclosing a rather prominent clitoris and also the urethral and vaginal openings. The lips are pigmented, but the clitoris is not. The perineal body between the vulva and anus is, as in all leaf-monkeys, very short, the vulva being situated high up between the dorsal parts of the callosities. In old parous females the lips of the vulva become partially obliterated, so that the vaginal orifice appears flush with the surface of the perineum.

In *Semnopithecus*, young specimens have a vulva essentially similar to that of *Kasi*, with the clitoris within the labia. In most older females the same condition was found in *S. e. thersites*. But in one old parous female a condition similar to that of Pocock's figure of *S. e. entellus* was found. Here the clitoris is elongated and dependent, and the margins of the vulvar slit appear to be continuous with the edges of the root

of the clitoris. In no sense, however, can the clitoris be said to be outside the vulvar slit, as it is in *Presbytis*. The condition in this last specimen and in the one figured by Pocock is entirely due to the stretching incident on parturition.

The females of *Kasi* agree further with those of *Trachypithecus* in the possession of the white patch of hair on the pubes. This patch develops before puberty. The underlying skin is pigmented in the adult, but in young animals it is white like the hair. No such patch occurs in any form of *Semnopithecus*.

### *Male genitalia*

There is little to add to the description of the male organs, beyond a note on the os penis. A short bone exists in the terminal part of the penis in the adult males of all races of *Kasi*. In the young animal it is absent, or represented only by cartilage, according to age. The fully formed bone is 12 mm. long and 1.5 mm. thick. It lies nearer to the dorsum of the penis, commencing distally in the glans dorsal to the termination of the urethra and extending back for some distance into the septum between the corpora cavernosa. It is subcylindrical, but slightly bowed, with the concavity dorsally. It is bluntly rounded distally but pointed proximally.

In *Semnopithecus* the os penis is similar in shape, but larger and more stoutly built. It measures 15 mm. long and 3 mm. thick. The proximal end is truncated, with a pointed apex dorsally and a bevelled surface below this. The distal end is more swollen than in *Kasi*.

There is no scrotum in the new-born *Kasi*, and it is not yet known at what age the testes descend. Puberty probably does not occur before four years of age at least in this genus.

### *Extremities*

In studying the macaques, de Beaux (1923) has evolved certain angular measurements to give accurate information on the state of webbing of the digits. These are; (i) the angle between a line drawn from the apex of the interdigital space between digits III and IV, to the same position between digits I and II, and another line drawn from the same point to a similar point between digits IV and V. This he terms the angle of syndactyly. (ii) The angle between the first line mentioned above and a line drawn through the long axis of the palm (or sole). This is the 'angle of syndactyly with the axis'.

These angles are very difficult to measure on preserved material on account of the rigidity of the digits and their usual fixation in an inconvenient position. It is only possible to make satisfactory studies on

fresh cadavera. Such material is not always readily to hand but the following figures indicate the measurements in such material as was available:—

TABLE I.—*Digital angles.*

<i>Examples measured</i>	<i>Hand</i>		<i>Foot</i>	
	<i>Ang. syn.</i>	<i>Ang. syn. axis</i>	<i>Ang. syn.</i>	<i>Ang. syn. axis</i>
<i>Kasi vetulus nestor</i> ♀ subad.	142°	70°	122°	82°
ditto. ♀ subad.	121	56	120	50
ditto. ♂ ad.	143	55.5	117.5	47.5
<i>K. v. philbricki</i> newborn	—	—	108	36
<i>Semnopithecus e. thersites</i> ♀ ad.	151	75	151	86.5
ditto. ♀ juv.	112.5	65	141	65

These figures indicate, as with the callosity angles, a wide range of individual variation. The amount of material examined is insufficient to indicate constant differences between *Kasi* and *Semnopithecus* in this connexion.

### 1. *Kasi johni* (Fischer)

#### Nilgiri Leaf-monkey

*Semnopithecus (Kasi) cucullatus*, 1862. Reichenbach, *Vollst. Naturges. Affen.*, p. 101

*Pithecus vetulus johni* Hill, 1934. *C. J. Sci.* (B) XIX, p. 79 (for full synonymy see this paper)

The Malabar race of the purple-faced monkeys is the type form of the genus *Kasi*.

There is little to be added to the description of this form, but the following data based on the examination of a large series of skins in the British Museum and Bombay Natural History Society collections may be of interest;—

*K. johni* is the most completely melanistic form of the genus. It is closely approached by *K. vetulus vetulus*, but microscopic examination of the hairs indicates a much heavier pigmentation in *K. johni*, although to the naked eye both forms appear equally black. Pigment is so

heavily developed in the hairs of *K. johni* that all the details of structure are masked thereby. The hairs, moreover, are in any given region longer than in *K. v. vetulus*.

The darkening of the general body hairs is shared to some extent by the hairs of those regions which in *K. vetulus* are greyish to white, e.g., whiskers, and sacral region. In *K. johni* the whiskers are as dark as the pileum, which is dark earthy-brown. The long hairs of the nape are the palest hairs on the body. The sacral patch is at most incipient in this species being frequently entirely absent. In all cases the main part of the individual hairs in this region is black, but a variable number of them have white tips. In some individuals it is but a superficial frosting of the base of the tail and neighbouring part of the rump. In others it is slightly more extensive, reaching the buttocks laterally and along the dorsal aspect of the proximal third of the tail. In several specimens the frosted region is divided into two by a black longitudinal stripe in the mid-line.

The pileum is darker than in lowland races of *K. vetulus*, but paler at the periphery than in the middle. Behind, the paler hairs are continuous with the long yellowish hairs of the nuchal region.

The whiskers are well developed and conceal the ears. They are not separated from the pileum by a black tract, but there are a few blackish hairs on the ears. In one specimen (B.M.No.79.11.21.591) collected by A. F. Christie (no locality given) the lower half of the whiskers were themselves black.

The black brow-fringe is as a rule better developed than in *K. vetulus*, but the scattered black hairs on the face are not more heavily represented than in the highland races of that species. Thus there is a moustache, a variable number of longer black hairs on the malar bone, and a median tract on the bridge of the nose. This latter tract has the reversal mentioned in connexion with the bear monkey in my monograph. There are no white hairs around the lips or chin, any hairs present here being black. The throat and ventral aspect of the trunk are very well clothed with black hairs.

The melanistic tendency in this species is also present in the new-born. The youngest specimens so far observed (two in the British Museum, both collected by J. R. O'Brien) are uniformly clothed with soft, silky black hair. From the field-notes, however, it is evident that skin-pigmentation is lacking at this stage as in *K. vetulus*. In one specimen there was no skin-pigment anywhere. In the other, pigment had commenced to deposit on the face. Both specimens were at the breast,

but may, notwithstanding, have been several months old. A specimen immediately after birth is badly needed to settle the question of general body colour in this species.

The fact that the female has the conspicuous patch of white hair on the pubes in this species as in the Ceylonese species has been confirmed. In immature specimens the skin of the same area lacks pigment also.

## 2. *Kasi vetulus* (Erxleben)

### The Ceylonese Purple-faced Monkey

*Cercopithecus senex*, 1777. *Erxleben, Syst. Reg. An.*, p. 24

*C. vetulus*, 1777. *Erxleben, loc. cit.*, p. 25

*C. cephalopterus*, 1780. *Zimmermann, Geogr. Ges.*, II, p. 185

*C. latibarbatus*, 1812. *E. Geoffr., Ann. Mus.*, XIX, p. 94

*Semnopithecus nestor*, 1833. *Bennett, P. Z. S.*, p. 67

*S. cephalopterus*, 1841. *Martin, Nat. Hist. Quadr.*, p. 482, also of Anderson, Blanford and Forbes

*Presbytis cephalopterus*, 1843. *Gray, Handlist*, p. 4, also of Waterhouse, Blyth, Kelaart, Tennent and Templeton

*P. ursinus*, 1851. *Blyth, J. A. S. Bengal*, XX, p. 155

*Pithecus vetulus*, 1923. *Hinton, Ann. Mag. Nat. Hist.* (9) XIII, p. 506, also of Phillips and of Hill, 1934, restricted

This is a polymorphic species to include all the Ceylonese leaf-monkeys other than the local race of *Semnopithecus entellus*. They are usually referred to locally as black wandroos (Sinhalese *Kalu vandhura*) to distinguish them from the *Semnopithecus* which is a light-coloured animal. Unfortunately much confusion has been brought about through the fact that only one geographical race of *K. vetulus* is truly black, and this one resides in a district where the Entelloid is unknown. Those animals that inhabit the territory adjacent to or occupied by Entelloids are greyish in colour, and at a distance may not appear much darker than the Entelloids themselves. Further, it must be remembered that white wandroos also exist. These are invariably albinistic mutants of one or other of the races of *K. vetulus*.<sup>1</sup>

The species may be defined thus;—

General colour grey to black; whiskers mainly or wholly white; a patch of shorter hair on the sacral region sometimes but not always paler than the rest of the back; hairs on occiput shorter than in *K. johni*.

<sup>1</sup> In the N.-C. P., where the subspecies *philbricki* occurs side by side with the Entelloid, the former is referred to as a *kalu vandhura* (i.e., black wandroo) and the latter as *sudu vandhura* (white wandroo).

Beyond this it is impossible to give a general description of *K. vetulus* on account of the wide range of variation exhibited by the four geographical races recognized.

### 2a. *Kasi vetulus vetulus* (Erxleben)

#### South-western Purple-faced Monkey

*Pithecus vetulus vetulus*, 1934. Hill, *C. J. Sc.* (B), p. 58 (q. v. for full synonymy)

The main distinguishing features of this race are;—

- (i) Intense black general coloration.
- (ii) Paleness and distinctness of the sacral patch.

Closer examination of material at my disposal has shown the tendency in some individuals of this race to have the lower parts of the whiskers brownish, or frankly brown, especially at the tips of the hairs. This tendency is an approximation to the conditions seen in *K. johni*. The bases of the hairs on the pale sacral patch are black or very dark grey.

Microscopic examination of the hairs of the dorsal region clearly separates them from those of *K. johni*. Individual hairs are shorter than in *johni*. They show the same general characters, but pigment is much less heavily deposited, so that it is comparatively easy to make out the detailed structure of the hair. Pigment is best developed in the cortex. The medulla is heavily pigmented, but only in patches.

### 2b. *Kasi vetulus nestor* (Bennett)

#### Western Purple-faced Monkey

*Pithecus vetulus nestor*, 1934. Hill, *C. J. Sc.* (B) XIX, p. 62 (q. v. for full synonymy)

This race is characterized by its small size, general grey colour, and its less distinct, though pale, sacral patch. The shade of grey of the body is subject to much individual variation. The whiskers are always white throughout, and meet under the chin to form a short beard. The bases of the hairs on the sacral patch are the same colour as on the back or paler.

All that need be added to the description concerns the structure of the hairs. These are similar in size and form to those of *vetulus*, but differ in the degree of pigmentation. Pigment is best developed in the medulla. In some hairs the medulla is pigmented continuously through the length of the hair. In others pigment is confined to localized

patches with pale areas intervening. Pigment occurs in the cortex in the form of very fine scattered granules only. The terminal portions of all the hairs are unpigmented.

## 2c. *Kasi vetulus monticola* (Kelaart)

### The Bear Monkey

*Pithecus vetulus monticola*, 1934. Hill, *C. J. Sc. (B)* XIX, p. 68 (q. v. for full synonymy)

The highland race of Ceylonese purple-faced monkey is readily distinguished by its large size combined with dark grey general coloration more or less uniformly distributed all over the body. Thus the pileum is darker than in any of the other races, whilst the rump-patch is typically absent. The whiskers are wholly white and very thickly planted.

The hairs differ from those of the other races chiefly in their great length and density. Individual hairs have a greater average thickness than in *K. v. nestor* and are more pigmented. Pigment is sparse in the cortex, being there of finely granular form. In the medulla it is heavily developed and comparatively little fragmented. The disc-shaped pigmentary bodies of the medulla are specially well marked in this race.

The following notes on the specimens of *K. v. monticola* in the British Museum collection are of some interest in view of the rarity of examples of this form. In this collection there are only three specimens. The oldest (52.5.9.16) is one sent by Kelaart and labelled merely 'Ceylon'. It is the skin of a young (half-grown) animal and is much faded. It is, however, a typical *K. v. monticola*, with a uniformly very dark upper surface, no paler on the cap or sacrum, though the hair is shorter in the latter region. The limbs and tail are the same dark hue, but the latter is brighter toward the tip, whilst the hands are jet black. The next, 11.9.9.1., is a male from Adam's Peak sent in 1908 by S. B. Bell. This specimen was alluded to in my monograph (p. 69) as having been examined by Phillips and pronounced atypical. I agree with this, for the specimen is not like the last uniformly dark, the cap and sacrum being paler. The sacral patch is extremely ill-defined. The whiskers and throat are dirty white, as is also the tip of the tail. The specimen is, however, more like a bear monkey than a *K. v. vetulus*, for it is very large and the hair is very shaggy, especially on the flanks. The third specimen (15.3.1.5.) is one from Pattipola, C. P. (6,210 feet), collected by E. W. Mayor in March, 1914. This is labelled

as having weighed 20 lb. in the flesh. It is a typical bear monkey. Pigment appears, as usual in the skin of this race, to have been absent from the ventral aspect of the trunk.

## 2d. *Kasi vetulus philbricki* (Phillips)

### Northern Purple-faced Monkey

*Pithecus vetulus philbricki*, 1934. Hill, C. J. *Sc. (B)*, p. 74 (q.v. for full synonymy)

Further evidence (*vide infra*) on the distribution of this race is suggestive that it is the product of the climatic conditions of the so-called 'dry zone' of Ceylon, and that, although it spreads southwards up the foot-hills bounding the west bank of the Mahaveli-ganga, its real centre of characterization is in the lowland plain of the north of the Island.

The race is distinguished mainly by its large size and very long, white-tipped tail. The rest of its characters overlap those of other races. Its general colour is similar to that of *nestor*, but as a rule the sacral area is poorly developed and ill-defined. The pileum is very variable being typically intermediate in colour between that of *nestor* and that of *monticola*. In one recent specimen, however, the pileum was paler than in any previously described Ceylonese animal. The general colour of the cap in this specimen (a female from Kala-oya) was creamy-white in the centre and buff at the periphery. In the same specimen the nuchal hairs were much elongated, approaching the condition in *K. johnei*. Other specimens from the same and neighbouring localities had a darker pileum, but not so dark as the individuals previously described from further east. Skin-pigmentation in this subspecies is as previously described. The following details may, however, be added. There is a considerable triangular naked field at the root of the tail surrounding the anus. This is darkly pigmented. The vulva is deeply sunk and the labia pigmented. The clitoris is prominent for a leaf-monkey, but within the labia and unpigmented. There may be a few greyish white hairs on the perineal body directed towards the vulva. In the male the triangular naked field is relatively smaller, and the callosities are contiguous over a considerable distance in the mid-line. The whole area is deeply pigmented. The scrotum is large and pigmented. The proximal half of the body of the penis is pigmented, the rest flesh-coloured.

The measurements below relate to a series of fresh specimens collected in February and July, 1935, in the North-Central Province.



TABLE II.—*Flesh measurements of K. v. philbricki*

No.	Locality	Sex and Age	Weight	Head and Body	Tail	Hind-foot	Ear
			Kg.	mm.	mm.	mm.	mm.
K 1.	Kala-oya, N.-C. P.	♀	Skin only	540	720	—	30
K 2.	"	♀ nb.	0.39	206	285	78	27
K 3.	"	♀ ad.	4.76	465	710	160	36
K 4.	"	♀ ad.	7.25	500	820	170	45
K 5.	"	♂ ad.	7.71	539	784	176	35
K 6.	"	♀ ad.	5.38	490	735	165	30
K 7.	"	♂ nb.	0.59	228	320	80	30
P 1.	Polonnaruwa, N.-C. P.	♂ ad.	6.0	615	850	183	33
P 2.	"	♀ juv.	2.5	497	695	145	34
P 3.	"	♂ ad.	6.0	665	826	180	34
P 4.	"	♂ ad.	6.0	640	873	184	37
P 5.	"	♂ ad.	6.0	605	840	178	36

The following further skull measurements should also be added to those previously published:—

TABLE III.—*Skull measurements of K. v. philbricki*

Measurement	Kala-oya ♀	Kala-oya ♀	Kala-oya ♂	Polonnaruwa ♂ ad.	Polonnaruwa ♀ juv.
	mm.	mm.	mm.	mm.	mm.
Max. cranial length	71	75	76	82	70
Max. cranial br.	59	59	60	60	54
Auricular ht.	33	38	34	35	39
Least frontal br.	32	30	28	35	34
Bimastoid	56	56	59	62	47
For. magnum l.	14	15	13	16.5	15.5
For. magnum br.	13	14.5	14.5	15.5	14
Palatal l.	37	33	43	39	30
Bizygomatic	73	73	77	81	60
Bipterygoid	30	34	36	39	28
Orbital ht.	21	23	22	21.5	18
Orbital br.	23	23	24	23	20
Nasal ht.	16	15	20	20	15
Nasal br.	9	9	8	10.5	8.5
Upper tooth row	28	29	28	27	24
Across m. 2	33	34	34	32	28
Condylar ht.	40	39	47	45	33
Mandibular l.	65	68	75	71.5	58
Bigonial	60	54	62	64	50
Lower tooth row	34	33	34	34.5	27.5

*New-born*

Two new-born specimens of this race were obtained alive near Kala-oya, N. C. P., in February, 1935. They are both much the same age, but differ in some important respects from the description previously given of the new-born of *K. v. nestor*.

Of the two, one, K. 7, a male, though larger, is undoubtedly the less advanced. It was obtained by shooting the mother which carried it at the breast. It lived for eighteen hours only. It was almost entirely covered with soft, downy hair. In colour this hair was almost white, but the tips of the hairs on the dorsal and ventral aspects of the trunk were blackish, giving a general impression of a very light grey. The tail was somewhat darker. The black brow-fringe was present, pointing mainly upwards. The trigeminal area of the crown was covered with grey hairs like the back, but the occipital area was quite white like the whiskers. Skin-pigmentation was scarcely begun, being present to a very slight degree in the palms and soles only. The face was uncoloured, as also were the ears and callosities. The four incisors were just appearing through the gums, and the crowns of the first molars were also visible, flush with the level of the alveolus.

The older specimen, K. 2, a female, was obtained alive on February 3, 1935, from a different troop from the preceding. It was accidentally dropped by the mother when another female of the same troop was shot. It lived for two weeks in captivity subsisting on cow's milk from a feeding-bottle. At the time of death the lower incisors were fully erupted; the upper incisors half erupted, and the first molars well above the alveolar level. In general colour it was darker than the preceding, but the paler occipital area was still very evident. The rest of the crown was darker like the back. On the back the mid-line was lighter than the hair further laterally, whilst on the flanks the colour was again light. A transverse dark band separated the pale occipital patch from the shoulders. The white patch on the pubes was already present. Skin-pigmentation was in advance of that of the preceding specimen. The face was slightly dusky, but with a brownish tint quite different from the lilac hue of the new-born *nestor*. The same tint occurred in the ears. The hands and feet were blacker; but the callosities were still unpigmented.

*Geographical distribution*

The discovery of several troops of *K. v. philbricki* in the neighbourhood of Kala-oya, N. C. P., considerably extends the westward range of this form. Specimens K. 1 and K. 2 were obtained to the west

of Kekirawa; two others were secured two miles to the east of the Kala-oya river; and two more two-and-a-half miles to the west of the river. The river therefore does not form a barrier to the westward range of this monkey. It raises the possibility that the full range may reach the west coast, and southwards may at one time have met and intergraded with *K. v. nestor*. At the present time, however, leaf-monkeys of any sort are unknown north of Colombo until the territory of the Entelloids is reached in the area north of Puttalam. Further expeditions in the Wilpattu Game Sanctuary may reveal the presence of this monkey therein.<sup>1</sup>

In concluding I have to tender acknowledgments for help received from the following;—to the staff of the mammalian department in the British Museum (Natural History), especially to Mr. M. A. C. Hinton, Mr. R. I. Pocock, and Dr. E. Schwarz for the facilities and assistance vouchsafed to me during my visits to that institution; to Mr. W. A. L. Schofield for obtaining the specimens of *K. v. philbricki*, and for many notes thereon; and to my demonstrator, Dr. P. K. Channugam, for making the microscopical preparations of hair upon which my observations on this subject are based.

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<sup>1</sup> Since the above was written further information has become available relative to the westward range of *K. v. philbricki*. In September, 1935, Dr. L. Nicholls, accompanied by Mr. E. C. Fernando of the Colombo Museum, visited the above game sanctuary. Several examples of the subspecies were obtained at Paymadu two-and-a-half miles to the east of the sanctuary on the Modaragam Aru. Others were seen in troops about two miles further west along the same river, which here forms the northern limit of the reserve. None were seen far from the river beds, and it is surmised that this animal cannot exist in comfort far from water, and that it is unlikely to range farther north than Marichechukkaddi at the mouth of the above river.

Mr. Fernando also collected some specimens of *philbricki* in July, 1935, at Polonnaruwa, N. C. P. All these were fairly typical, with dark glossy coats, and approached, if anything *monticola* in size and coat characters.

The full range of *philbricki* would therefore appear, as suggested above, to extend right across the Island in its northern lowland portion south of latitude 8°30', i.e., from Marichechukkaddi on the west to Nilaveli on the east coast.

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## EXPLANATION OF PLATE II

## PLATE II

Photographs of the perineal region of a number of young and adult female leaf-monkeys.

- Fig. 1. *Trachypithecus obscurus* adult (from Siam)
- Fig. 2. *Kasi vetulus nestor* immature
- Fig. 3. *Semnopithecus entellus thersites* infant
- Fig. 4. *S.e. thersites*, multipara
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Fig. 1

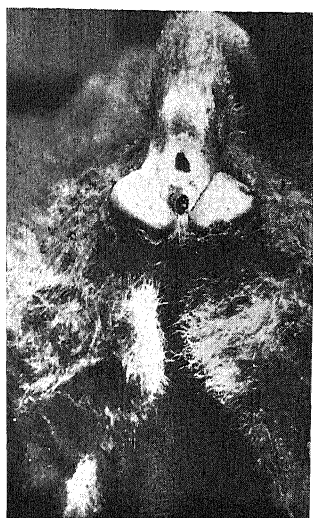


Fig. 2



Fig. 3

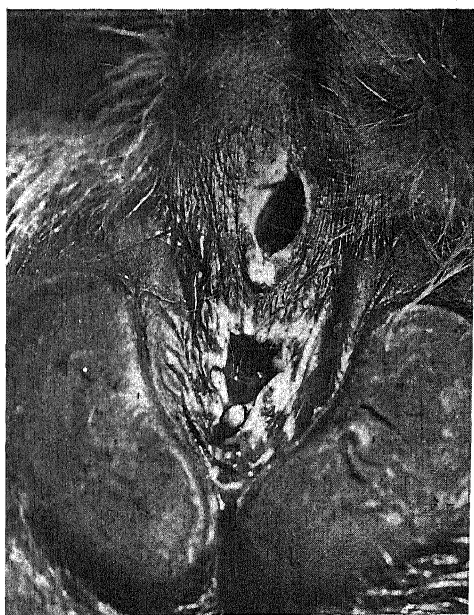


Fig. 4

THE VULVA IN VARIOUS LEAF-MONKEYS.



## On a Hybrid Leaf-monkey; with Remarks on the Breeding of Leaf-monkeys in general

BY

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(With Two Text Figures and One Plate)

Little is known of the reproductive behaviour or breeding habits of any of the leaf-monkeys. The study of a hybrid foetus of this group will therefore serve as a suitable introduction to this important subject.

The specimen belongs to the Colombo Museum, whence it was loaned to this department through the kindness of the Director, Mr. A. H. Malpas, with the information that it had been taken from the body of an adult female Purple-faced Leaf-monkey (*Kasi vetulus nestor*) who had died in labour in the Museum Zoo in May, 1929. She had been kept in a cage along with a male Grey Langur (*Semnopithecus entellus thersites*) by whom she had apparently been impregnated. The period of gestation had not been noted.

The specimen comprises the uterus and its contents. The uterus had been opened and the foetus was attached by the umbilical cord to a simple discoidal placenta, which was still *in situ* on the uterine wall. The mother had evidently died during the second stage of labour due to exhaustion. The labour had been prolonged either as a result of an abnormally large foetus, or as an effect from a face presentation.

### The Uterus

After making a post-mortem incision, this organ had contracted down to about four times its size in the non-pregnant state. It presented no abnormality. The decidua vera was thick, spongy and smooth. It



was semitransparent so that a number of dark irregular spots could be seen shining through it. Its surface was finely wrinkled due to the contraction of the uterine muscle after opening.

### The Placenta

The placenta is remarkable for a monkey in being composed of a single subcircular disc. I have previously seen only the bidiscoidal form in monkeys of this group. The disc is attached to the left posterior part of the fundus uteri. It is thick and raised up from the decidual surface leaving a well-marked groove peripherally between itself and the uterine wall (Fig. 1). The total thickness of the disc and uterine wall in the formalin-fixed specimen is 32 mm. The placenta has a maximum diameter of 108 mm.

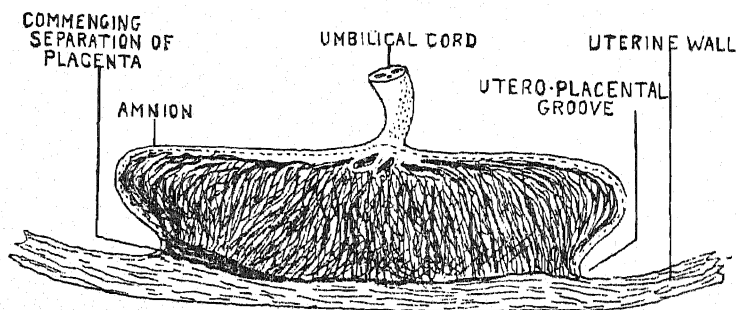


Fig. 1. Diagrammatic vertical section through the placenta and uterine wall in a parturient Purple-faced Leaf-monkey.

### Umbilical cord

The cord was normal in appearance. It measured 244 mm. long and was attached somewhat eccentrically on the placenta. The vessels had an anti-clockwise twist in passing from foetus to placenta.

### The Foetus

The intrinsic interest in the foetus lies in its hybrid parentage. Although less valuable than if it had reached maturity, since many of the diagnostic characters of the species concerned are not present at the

time of birth, yet sufficient characters are available to indicate its bispecific parentage. These will be noted in the systematic description of the foetus which follows;—

#### *Foetal position*

The foetus had been hardened in what was, presumably, its posture *in utero*. This is in a state of full flexion of all the joints, except that the head is almost at the full limit of extension. Assuming a head-presentation this position would have resulted in a full face presentation. The eyes are closed, but the lids not fused. The mouth is open.

#### *Pilous system*

The hairy coat has the usual development seen in this group of monkeys about the time of birth. The face is mainly naked, but there are a few stiff hairs, possibly rudimentary sinus hairs, on the upper lip and on the orbital margin laterally. Eyelashes are well developed on both lids. The characteristic brow hairs are very evident, and agree in size and arrangement with the male parent rather than with the female. The longest reach 20 mm. in length. They are directed forwards with an arch-like arrangement. In the mid-line they are continued down on to the bridge of the nose for 5 mm. their direction here being downwards. Below this point short microscopic hairs are also directed downwards there being no reversal on the bridge as seen in *Kasi*.

On the crown, the hair arrangement retains the more primitive form seen in *Kasi*, i.e., with the simple cranio-caudad stream, there being no indication of the frontal radiation found in *Semnopithecus*. At the sides, the stream tends to diverge somewhat backwards on to the preauricular region. There are no lengthened side whiskers, and the hairs of this region are the same colour as those on the crown, namely, black. These characters are those of *Semnopithecus* rather than *Kasi*.

The rest of the body is covered with sparse black hairs, except the ventral aspect of the thorax which has paler hairs. The tail is well clothed with black hairs. There is no bare patch on the ventral aspect of the root of the tail. There is, at the tip, a well-marked terminal tuft.

In addition to the face the following regions are naked or nearly so;—the ears have but a few sparse black hairs on the helix, on the flat part of the outer surface and on the cranial surface towards the root. The callosities are quite naked as is also the area round the anus. The

penis has a few whitish hairs on its ventral aspect and these are continued back on the perineum as far as the callosities. There is no scrotum. The palms and soles are entirely naked. Hair clothes the dorsum of each digit as far as the penultimate phalanx.

### *Skin-pigmentation*

No pigment has developed anywhere in the skin, except for a slight bluish tinge in the ears and on the dorsum of the fingers and nail-beds.

### *Face*

The face is short, wide and squarish. No pigment is developed, and only such traces of hair as have been mentioned above. The nose-bridge is prominent, and leads down to a broad, raised external nose with well-marked alae and septum. On either side the two naso-labial sulci are well shown. The internarial angle is  $116^{\circ}$ . The lips are thin and not protruding. The lower jaw is narrow and the chin undeveloped. The upper lip has a frenum, but the not lower. The gums are toothless and resemble those of a human full-term foetus.

### *Ears*

The ears are relatively very large. In shape they resemble those of *Semnopithecus*, and differ from those of *Kasi*. They possess a well-marked helix in the upper part, but this terminates above and behind in a sharp point. The posterior border is thus thin and entire, with no folding. There is below, a supratragus guarding a rudimentary bursa.

### *Perineal region*

The penis is short and completely hooded by its prepuce. No skeletal support is present at this stage. The scrotum is undeveloped, the testes being still within the internal abdominal ring. The callosities are bright pink in colour, subtriangular and confluent in the mid-line over their whole depth. The anus is situated in a small naked field.

### *Extremities*

The limbs have attained the typical Leaf-monkey form, with long, narrow hands and feet. The thumb is rudimentary. The nails are well developed, but are slightly more advanced on the toes than the fingers, but more so on the pollex than hallux. The subungual fold is exposed on all the fingers but covered on the toes. Papillary ridges are well developed on all the digits.

*Somatometry*

In Fig. 2 a diagrammatic representation has been made according to the methods advocated by A. H. Schultz (1929) with slight modifications. Half the diagram represents the hybrid Leaf-monkey fetus. The other half shows a foetal *Colobus* monkey of 112 mm. crown-rump length taken from Schultz (1924). This is the nearest specimen available in the literature for comparison. The two fetuses have been reduced to the same sitting-height. The figures upon which the diagram is based are given in Tables I and II.

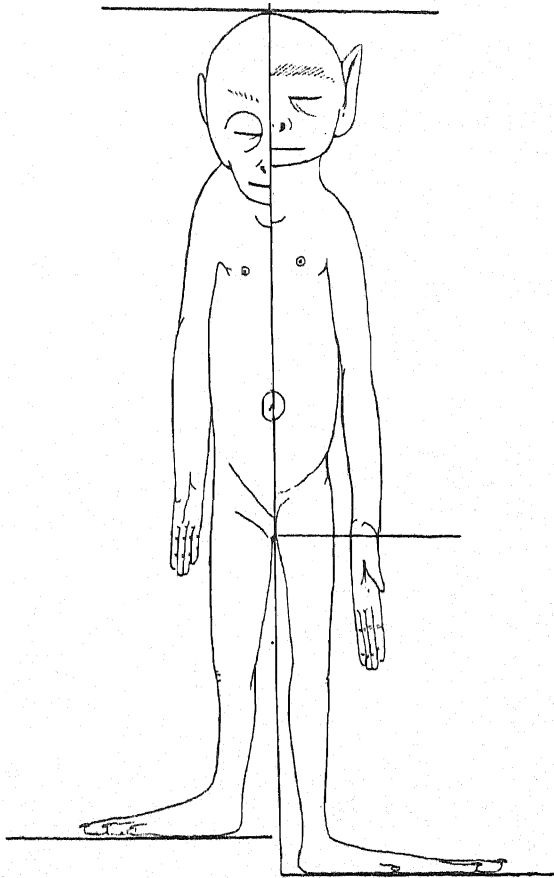


Fig. 2. Diagrammatic representation of body proportions of hybrid Leaf-monkey (on right) compared with a *Colobus* fetus of 112 mm. sitting-height (on left). The *Colobus* has been taken from a figure by Schultz (1924).

TABLE I.—Absolute measurements of full-term hybrid foetus (*Semnopithecus entellus thersites* ♂ × *Kasi vetulus nestor* ♀) compared with those of two new-born infants of *Kasi vetulus philbricki*

No.	Measurement (in mm.)	Full-term Hybrid ♂	New-born <i>K. v. phil-</i> <i>bricki</i> ♀	New-born <i>K. v. phil-</i> <i>bricki</i> ♂
1.	Sitting-height	185	209	231
2.	Tail length	287	285	320
3.	Thoraco-abdominal ht. (suprasternale-symphysion)	101	123	123
4.	Symphysion-thelion	86	106	92
5.	Symphysion-omphalion	34	45	30
6.	Bisacromial diam.	53	52	63
7.	Bimammillary diam.	19	25	30
8.	Bitrochanteric diam.	39	38	56
9.	Transverse thoracic diam. (opp. nipple)	38	40	50
10.	Sagittal thoracic diam.	39.5	44	39
11.	Circumference of thorax	137	138	157
12.	L. of brachium	52	60	63
13.	L. of antebrachium	53	68	63
14.	L. of hand	56	51	61
15.	L. of thumb	28	29	28
16.	Br. of hand (across metacarpo-phalangeal joints II-V)	18	18	22
17.	L. of thigh	66	68	64
18.	L. of crus (tibiale-malleolare)	61	68	64
19.	Malleolare-sole	12	11	13
20.	L. of foot	73	73	81
21.	Br. of foot (across all metatarso-phalangeal joints)	18	20	22
22.	Glabella-max. occipital point	62	58	64
23.	Max. cranial breadth	49	49	54
24.	Auricular ht. (Tragion-vertex perp. to eye-ear horizon)	31.5	36	39
25.	Nasion-inion	61	62	62
26.	Biauricular diam.	49	46	55
27.	Circumference of head thro' glabella	177	175	180
28.	Sagittal arc	80	90	90
29.	Transverse arc	98	104	110
30.	Total facial height (nasion-gnathion)	28	29	34
31.	Upper facial ht. (nasion-cheilion)	22	21	21
32.	Bizygomatic diam.	46	38	50
33.	Nasal ht.	12	14	14
34.	Nasal br.	11.5	8	11
35.	Br. of nasal septum	3	3	2
36.	Interocular width	8	8	10
37.	Br. of mouth	21	22	24
38.	L. of ear	31	28	33
39.	Br. of ear	21.5	21	24

TABLE II.—Indices of the same foetuses as Table I

No.	Index	Formula <sup>1</sup>	Hybrid ♂	K. v. phil- bricki ♀	K. v. phil- bricki ♂
1.	Tail-index	$\frac{1}{2} \times 100$	64.5	98.5	72
2.	Relative bisacromial	$\frac{4}{3} \times 100$	52.5	42.5	51.5
3.	Rel. bitrochanteric	$\frac{3}{3} \times 100$	38.6	29.25	45.5
4.	Rel. circumference of thorax	$\frac{11}{3} \times 100$	135.8	112.5	127.5
5.	Thoracic index	$\frac{9}{10} \times 100$	96.4	92	128
6.	Rel. bimammillary	$\frac{7}{9} \times 100$	50	62.5	60
7.	Rel. position of nipple	$\frac{4}{3} \times 100$	85.1	86.2	74.5
8.	Rel. pos. of umbilicus	$\frac{5}{3} \times 100$	33.7	36.5	24.5
9.	Rel. l. of upper limb	$\frac{12+13+14}{3} \times 100$	159.5	145	152
10.	Humero-radial index	$\frac{13}{12} \times 100$	101.8	113	100
11.	Forearm-hand index	$\frac{14}{13} \times 100$	105.8	75	96.5
12.	Hand index	$\frac{14}{12} \times 100$	33.22	35.4	36.2
13.	Rel. l. of lower limb	$\frac{17+18+19}{3} \times 100$	137.6	111	107
14.	Femoro-tibial index	$\frac{18}{17} \times 100$	92.4	100	100
15.	Leg-foot index	$\frac{19}{18} \times 100$	119.4	107	126.5
16.	Intermembral index	$\frac{12+13+14}{17+18+19} \times 100$	115.5	125.5	133
17.	Femoro-humeral index	$\frac{17}{17} \times 100$	78.8	88	98.5
18.	Tibio-radial index	$\frac{18}{18} \times 100$	86.9	100	98.5
19.	Foot-hand index	$\frac{18}{16} \times 100$	76.7	70	75.4
20.	Rel. size of head	$\frac{27+28+29+25+26+24}{4 \times 1} \times 100$	83.6	76.2	72
21.	Head-trunk index	$\frac{22 \times 23 \times 24}{4 \times 3} \times 100$	50.4	38.75	43.25
22.	Cephalic index	$\frac{22}{22} \times 100$	79	84.5	84
23.	Length-height index of head	$\frac{24}{22} \times 100$	50.8	62	61
24.	Sagittal-vault index	$\frac{25}{25} \times 100$	76.3	68.75	68.75
25.	Face-trunk index	$\frac{26}{26} \times 100$	27.7	23.6	27.6
26.	Rel. size of upper face	$\frac{27 \times 28 \times 29}{27+28+29+25+26} \times 100$	14.2	13.2	12.7
27.	Vert. cephalo-facial ind.	$\frac{28}{28} \times 100$	89	80.5	87
28.	Upper face index	$\frac{29}{28} \times 100$	47.8	55.5	42
29.	Rel. nasal ht.	$\frac{30}{31} \times 100$	54.6	66.5	66.5
30.	Nasal index	$\frac{31}{30} \times 100$	95.8	57.2	78.5
31.	Rel. interocular br.	$\frac{32}{32} \times 100$	56.8	21	20
32.	Ear index	$\frac{33}{33} \times 100$	69.4	75	72.25
33.	Rel. size of ear	$\frac{34 \times 35}{29 \times 30} \times 100$	38.6	35	31.6

<sup>1</sup> The figures in the 'formula' column relate to the number of the measurements in the Table I.

Examination of Fig. 2 reveals many differences between the foetal *Colobus* and the foetal leaf-monkey, and at the same time shows some curious characters in common. Schultz estimated his *Colobus* as equivalent in development to a human foetus of the 20th week, whereas the hybrid leaf-monkey was definitely at full-term. Moreover a monkey at full-term is definitely more advanced in development than a human foetus at the same epoch. A good deal of growth and alteration in bodily proportions must, therefore, have occurred in the hybrid beyond the stage exhibited by the *Colobus* foetus. The differences that are to be explained on these grounds are: (i) the relative increase in the length of the limbs, (ii) the relative elongation of the hand and foot, (iii) the alteration in the cranio-facial proportions, and (iv) the great increase in the size of the ear.

The following characters seem to have been little affected by the growth from the *Colobus* stage, for the relative positions of the parts concerned are almost identical when the two specimens are reduced to the same sitting-height, (i) the positions of the suprasternale, (ii) nipples and (iii) umbilicus. The symphysis pubis is somewhat higher in the leaf-monkey than in the *Colobus*. The intermembral index is much the same despite the elongation that has occurred in the leaf-monkey. In this elongation, the thigh and brachium are less affected than the more distal segments of the limbs, the foot being affected most of all. The absence of the thumb in *Colobus* and its rudimentary nature in the leaf-monkey are generic characters.

In the head lie the greatest differences between the two specimens. The greater relative size of the cranium in the *Colobus* is due to its age. The diminution of the cranium in the leaf-monkey gives the face greater prominence and renders the neck more obvious. The narrower nasal septum in the leaf-monkey is of generic importance. The broader mouth and narrow lower jaw are due to growth changes and would have surely occurred in the *Colobus* had it continued to develop.

In Tables I and II the proportions of the hybrid leaf-monkey have been compared with those of two new-born infants of the Purple-faced leaf-monkey (*Kasi vetulus philbricki*). The two are not quite the same age, as their measurements show. Unfortunately, no example is at present available for comparison of a pure *Semnopithecus* foetus or new-born. The tables indicate that the body proportions of the hybrid and of the pure new-borns of *Kasi* are much the same, agreement being closest with the smaller of the two specimens of *Kasi*. The main discrepancies between the hybrid and the specimens of *Kasi* relate to

the circumference of the chest and the thoracic index. In the thoracic index the hybrid is close to the younger *Kasi*. The older *Kasi* has undergone definite growth changes whereby its chest has broadened at the expense of its depth. The relative bitrochanteric diameters also differ, the hybrid here being closer to the larger *Kasi*. These differences must be considered as purely individual on the evidence of the available specimens. The relative positions of the nipple and umbilicus, and the relative proportions of the limbs and their segments, are remarkably similar in all the specimens. The head is relatively larger in the hybrid foetus, and the proportions of its length, breadth and height differ somewhat from that of both specimens of *Kasi*. These differences can hardly be due to their difference in age, and must tentatively be regarded as due to the influence of the paternal parent. All the specimens agree in the relatively large size of the ear.

### *Skeletal system* (Plate III)

The following description of the state of development of the skeleton is based on radiographic examination. It indicates the fact, already well known in relation to the Simiidae, that the degree of ossification in the skeleton in a monkey at birth is well in advance of the human child at the same period.

The cranial bones show evidence of moulding incident to parturition. The apex of the occipital squame is overriding the hinder end of the parietals. The bregmatic fontanelle is smaller than in a human child at birth, but can be felt through the skin. It is much larger in the smaller of the two specimens of *Kasi* mentioned above, but the difference is probably individual only. The X-ray shows well the outline of the cranial cavity with its characteristic dorso-ventral flattening. The large tympanic annulus is also indicated clearly. In the jaws all the milk teeth show calcification, and this process seems to be complete in all but the last molars. The vertebrae appear to be in the same condition as in the human full-term child. Ossification is present in all but the last two or three caudal vertebrae, whilst rudimentary ossification centres are present in the chevron bones of the first two caudals. The clavicles are well ossified as in Man. There is no centre at the upper epiphysis of the humerus. A commencing centre can be seen opposite the elbow joint, but it is difficult to determine whether this belongs to the humerus or to the ulna. Two minute centres are visible in the right carpus. These are situated near the radial side close together and probably represent the scaphoid and semilunar. In the degree of development of the carpus this leaf-monkey appears to be intermediate between the human and the



macaque. In a two-days post-natal *Macaca sinica* all the carpals are represented by large ossifications except the unciform and pisiform. The shafts of all the metacarpals and phalanges are present, but there are no epiphyseal centres. Here again the macaque is considerably further advanced. The three main elements of the pelvic girdle are bony on each side, but no secondary centres are visible. The upper end of the femur has no bony centre, but the lower end has a good sized one. There is also a centre in the upper end of the tibia, and a small flat one at the lower end. A doubtful centre at the side of this probably represents the external malleolus of the fibula. In the tarsus the os calcis and astragalus are well formed, but none of the distal tarsals is represented in bone. Here again the two-days old macaque is well ahead in that all its tarsals are ossified to some extent. The metatarsals and phalanges are in the same condition as the corresponding bones in the hand.

#### DISCUSSION ON THE BREEDING OF LEAF-MONKEYS

Leaf-monkeys are delicate animals. They rarely survive a voyage to Europe, so that little opportunity has hitherto arisen for the scientific study of their reproductive habits. Even in their own land they stand captivity rather badly compared with the hardier macaques, and it is seldom that they can be induced to breed, or even to exhibit sexual behaviour. When breeding does occur it seems just as likely to happen between different species as between males and females of the same kind. The earliest instance of breeding of these monkeys in the literature relates to the production of a hybrid between Phayre's Leaf-monkey (*Trachypithecus phayrei*) and the related *T. cristatus*. This was reported by Sanyál (1893) to have occurred in Calcutta. The monkey which forms the basis of this communication lends further support to the above statement regarding hybridization. The only other information on the subject has been collected by Zuckerman in several papers on the reproductive behaviour of Primates. In 1931 (a) he recorded all the births that had taken place among monkeys in the London Zoo. The only leaf-monkey mentioned in the list is one which Zuckerman labels *Presbytis aygula*, but which would appear to be not that species, but the Capped Leaf-monkey, *Trachypithecus pileatus* judging from photographs published by Pocock (1928) and Wood-Jones (1929). This species seems to have fared more comfortably in captivity in Europe than most of its kind, four babies having been born in London. The dates given by Zuckerman are 7/IV/12, 27/IX/13, 22/I/15 and 22/XI/15. These do not lend support to the view that there is a regular periodicity or breeding season in these monkeys.

Information gathered locally does not add much to the known facts in this connexion, but, such as it is, it needs recording. No other instance of breeding beyond the monkey described above has happened in the Colombo Museum collection<sup>1</sup>. In my own collection I have not yet succeeded in getting a female leaf-monkey pregnant, though pairs in obvious breeding condition have been kept together for some time. The male in these circumstances has been noted to emit regularly his early morning call with dilated laryngeal pouch. I have only come across one other instance of the male *Kasi* doing this in captivity, and that was in the private collection of Sir Solomon D. Bandaranaike concerning which further details are mentioned below. The male takes little interest in the female unless she presents to him. This she does frequently by raising her genital region before him and accompanying the gesture by spasmodic movements of the clitoris. He may or may not be attracted by this behaviour, but as far as my own specimens are concerned the procedure has never induced the male to copulate in my presence, though he was often sufficiently stimulated to have attained an erection.

The menstrual cycle in the female is inconspicuous. Fully mature females of *Kasi* and *Semnopithecus* have two to three days bleeding at roughly monthly intervals. The flow is slight and is unaccompanied by swelling or other changes in the external genitalia. On the evidence of a single female kept by Mr. R. H. S. Schrader at Negombo puberty in the female of *Semnopithecus* occurs at four years of age. She was obtained at Tammanewa, N.-C. P., on 9/II/29 and her age was estimated fairly accurately at about two months (she had a few milk teeth only). She first menstruated on 28/VI/32 the discharge at this first cycle being thick and gummy. She commenced at this time to present her genitalia frequently to her owner. She menstruated next in the middle of August the discharge being now bloody and mixed with mucus. The flow did not cease until the 23rd August. Unfortunately this interesting animal died shortly after these observations had been made, so that it was not possible to study any further cycles.

Sir Solomon D. Bandaranaike has supplied me with some very valuable information relative to the breeding of leaf-monkeys in his private collection at Veyangoda, W.P. This gentleman has been very fortunate in his success with these monkeys and has had no less than five babies born in captivity. Three of these have been examples of the

<sup>1</sup> Whilst this paper was in the Press another hybrid leaf-monkey was born in the Colombo Museum collection. This was a male infant born of a male *Kasi vetulus nestor* out of a female *Semnopithecus e. thersites*, i.e., the opposite cross to the one described herein. A full description of this hybrid will form the subject of a later contribution, but it is remarkable that in this case, as in the one discussed above, the child resembles the maternal parent more than the paternal.

albinistic mutant of *Kasi vetulus nestor*, the others have been normal dark examples of the same race. One of the white babies was the result of a cross between a white male and a dark female, and shows therefore the tendency for the albinistic character to be transmitted to the offspring. Sir Solomon has not noted any special time of the year when the babies are born, thus confirming the evidence based on the London Zoo births.

As far as the habits of wild leaf-monkeys are concerned the published accounts are even more meagre. The pioneer work was that of Heape (1894) on menstruation in *Semnopithecus entellus*. Heape's work has been discussed and criticized recently by Zuckerman (1931) for its interpretation does not accord with modern views on the menstrual cycle. Blyth (1843) quotes Moor's *Hindu Pantheon*, p. 320, as stating that *S. entellus* in Bengal has not unfrequently twin offspring. In these cases one young one is held under its mother's arm and the second one clings to her neck.

Breeding in two other leaf-monkeys has been recently discussed by Zuckerman. In 1931 he noted that in *Trachypithecus cristatus*, in Borneo, a nursing female was shot with a two months old baby on 17/6/30. In 1933 he gave information relative to a related species, *T. pyrrhus*, in Java. In November were obtained one nursing, eight non-pregnant and seven suspect females, together with eight pregnant animals (two early, three mid- and three late pregnancies). In December two females are recorded, one in early pregnancy and one puerperal. In January were obtained two puerperal, three non-pregnant and one in mid-pregnancy. Zuckerman concludes that the amount of material is insufficient from which to draw any conclusions. His general view would seem to be, however, that leaf-monkeys do not differ from other Old-World monkeys in having no special breeding season.

Recent valuable field work by McCann (1933) on several species of Indian leaf-monkeys has convinced this author that the forms he has studied have a breeding season in the winter months, most of the babies being born in February and March. He gives the breeding season of *S. entellus* from October to March and states that most of the young are born after January. In the Terai forest most of the females of *S. schistaceus* had new-born young or were pregnant in February. The Capped Leaf-monkey (*T. pileatus*), in Changchang Pani in the Naga territory, is described as having a similar breeding season and to be polygamous. It should be noted that all the above monkeys reside in those parts of British India which experience a definite cold season. The only monkey mentioned by McCann, from parts of India which do

not suffer a cold season, is the Nilgiri species (*Kasi johni*). The data given for this species are very inconclusive. At Kodaikanal in the Palni Hills a female was shot which contained a full-term foetus on 8/V/19. In the Tinnevely Hills new-born specimens were obtained on December 20th and 29th (year not given). As far as it goes this information seems to point to the view that the species breeds continuously.

My own experiences with Ceylonese species points in the same direction. In September, 1932, at Hiyare, near Galle, S.P., a number of females of *Kasi v. vetulus* was observed and some were shot. Several females were carrying babies. One juvenile was shot and proved to be about a quarter grown. Two females were pregnant at a stage corresponding to a five-months human pregnancy.

Specimens of *Semnopithecus thersites* were obtained for me by Mr. W. A. L. Schofield at Kala-oya, N. C. P., on January 1, 1935. Two pregnant females were among them, one containing an embryo at a stage equivalent to a human pregnancy of five weeks, and another equivalent to an eight weeks human embryo. Another very early pregnant stage was obtained by one of the Colombo Museum collectors at Sigiriya in November, 1933. All these embryos had they reached full-term would not have been born before April or May of the succeeding year.

#### SUMMARY AND CONCLUSIONS

1. An example of successful crossing between two species of Leaf-monkey is recorded.
2. The foetus, a full-term male, is described in detail, and characters derived from both parents are indicated.
3. The foetus has been measured and its proportions compared with a foetal *Colobus* and with new-born specimens of *Kasi vetulus philbricki*.
4. A discussion is added relative to the reproductive behaviour and breeding habits of Leaf-monkeys in general. The available published data have been analysed and compared with new facts recorded locally dealing with the breeding of Leaf-monkeys both in captivity and in the wild state. Although the data are still insufficient to give a decisive statement as to whether or not a definite breeding season occurs in these monkeys, the evidence seems to point rather in favour of continuous breeding as in other Old-World monkeys.

In conclusion it is my pleasant duty to acknowledge my indebtedness to Mr. A. H. Malpas, Director, Colombo Museum, for his generosity in

laying this interesting and valuable specimen at my disposal. I must also thank a number of others for placing information and specimens at my disposal, especially to Sir S. D. Bandaranaike, G.C.M.G.; Mr. W. A. L. Schofield and Mr. R. H. S. Schrader. The details of their contributions have already been mentioned.

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 (b) 1933—ditto., pt. VI, *P. Z. S.*, p. 1062

#### EXPLANATION OF PLATE III

##### PLATE III

Radiograph of the hybrid full-term foetus and placenta (*Semnopithecus entellus* *thersites* ♂ × *Kasi vetulus nestor* ♀)

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RADIOGRAPH OF HYBRID LEAF-MONKEY FOETUS.



## NOTE

### Avocets (*Recurvirostra avocetta avocetta*) at Minneriya

As Wait (*Birds of Ceylon* 2nd Ed. page 347) states that the Avocet in Ceylon is 'A very rare straggler in winter; has been obtained near Jaffna, and there are two specimens in the Colombo Museum from Hambantota', it would seem to be worth putting on record that, at Minneriya Tank in the N.-C. P., I saw no less than eleven, on July 14th, 1935.

This tank has recently been declared a Bird Sanctuary and I visited it in order to ascertain what birds were to be seen and whether they appeared to be undisturbed. The water in the tank was very low indeed, far lower than I had ever seen it before, with only a comparatively small area, adjacent to the bund, remaining submerged.

Birds were present in great numbers. There were large flocks of Painted Storks (*Ibis leucocephalus*), White Ibises (*Threskiornis melanocephalus*) and Spoonbills (*Platalea leucorodia major*) on the mud-flats, together with Purple Herons (*Ardea purpurea manillensis*), Grey Herons (*Ardea cinerea rectirostris*) and Egrets of several species. On the water were large flocks of Cotton Teal (*Nettapus eoromandelianus*) and Cormorants of two species, while in the shallows were numerous Pheasant-tailed Jaçanas (*Hydrophasianus chirurgus*), Black winged Stilts (*Himantopus h. himantopus*) and Red-wattled Lapwings (*Lobivanellus indicus indicus*) with here and there a few Indian Kentish Plovers (*Leucopoliis alexandrinus seebohmi*), Jerdon's Little ringed-Plovers (*Charadrius dubius jerdoni*) and Wood-sandpipers (*Tringa glareola*).

The Avocets were scattered over a small area of shallow water, feeding or standing preening their feathers, in company with a few Grey Herons and Painted Storks and numerous Stilts and Jaçanas. They all appeared to be in the full black and white breeding plumage and as they took no notice of my car, I was able to examine them through field glasses, at my leisure.



Undoubtedly the birds at this tank are beginning to appreciate the fact that they are in a Sanctuary. They appeared to be far tamer here than at any other tank I visited. They took no notice of my car nor of one or two men who were working near.

At a neighbouring tank, the Stilts, Indian Kentish Plovers, Jerdon's Little ringed-Plovers, Red-wattled Lapwings and Jaçanas were breeding and most probably some of them were nesting at this tank too.

W. W. A. PHILLIPS

July 16th, 1935.

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## PROCEEDINGS OF THE CEYLON NATURAL HISTORY SOCIETY, 1933 SESSIONS

### Twenty-first Annual General Meeting

Minutes of the Twenty-first Annual General Meeting of the Ceylon Natural History Society, held on February 14th, 1933.

Proceedings commenced with the President, Mr. G. M. Henry in the Chair, there were present thirty-three members and visitors.

The minutes of the previous General Meeting were read and confirmed.

The President then read out the amendment to paragraph 5 of the Constitution and Rules of the Society as adopted by the Council of the Society.

' 5. At the Annual General Meeting, the Ordinary and Life Members of the Society will elect the Council for the ensuing year, with the exception of the retiring President who will become automatically a Vice-President. The Student Member of the Council will be elected by the Student Members of the Society. The two Vice-Presidents with the longest continuous service will not be eligible for re-election as Vice-Presidents until a period of one year has elapsed, but shall be eligible for election as members of the Council. Vacancies arising during the year will be filled by the Council.'

The Honorary Secretary's Report and the Honorary Treasurer's Statement, which were in the hands of the members, were adopted.

Mr. D. R. R. Burt was elected President for the year 1933, and took the chair. The remaining office-bearers were elected as follows :—

*Vice-Presidents.*—Dr. A. Nell, Prof. N. G. Ball, Prof. F. O'B. Ellison, Mr. G. M. Henry and Dr. J. Pearson.

*Honorary Secretary.*—Dr. W. Fernando.

*Honorary Treasurer.*—Prof. W. C. O. Hill.

*Council.*—Mr. C. T. Symons, Mr. W. W. A. Phillips, Dr. S. E. Fernando, Mr. E. C. T. Holsinger, Mr. L. G. O. Woodhouse, Mr. P. E. P. Deraniyagala and Mr. S. E. Dias.

Dr. J. Pearson then gave an account of ' The Principles of Zoological Nomenclature '.

Mr. A. L. Johnpulle exhibited slides of *Culicoides anophelis*, a dipteran parasite of the mosquito, *Anopheles culicifacies*, and of an abnormal mosquito which was apparently a female but was provided with palpi pertaining to a male.

Mr. D. R. R. Burt exhibited a series of mice obtained by crossing the Ceylon House Mouse, *Mus dubius*, with the albino variety of the European mouse, *Mus musculus albula*.

### One Hundred and Sixteenth General Meeting

Minutes of the One Hundred and Sixteenth General Meeting of the Ceylon Natural History Society, held on 7th March, 1933.

The President, Mr. D. R. R. Burt, took the chair; there were twenty-one members and visitors present.

The minutes of the last General Meeting were read and confirmed.

Dr. W. C. O. Hill exhibited specimens of *Tarsius spectrum* and *Nycticebus* sp.

Mr. W. W. A. Phillips then read a paper on 'The Work and Aims of the Ceylon Game and Fauna Protection Society'.

Mr. Phillips gave an account of the history of the Ceylon Game and Fauna Protection Society and the continuous efforts made by the Society, since its inception in 1894, to combat the pitiless course that continues with us to the present day and which is still the chief enemy that periodically threatens the existence of many species of our wild life—namely 'commercial exploitation'. He said the chief aim of this Society is to persuade Government to provide the necessary funds and machinery for the enforcement of the Game Laws either as they exist at present or in an amended form in order to give greater protection to some of the rarer or more interesting forms and the provision of suitable Wild Life Sanctuaries, or Fauna and Flora Reserves, in each of the three climatic zones of the Island as being the surest method of ensuring the survival of all the most interesting endemic species.

At the conclusion of Mr. Phillip's paper the following resolutions were unanimously adopted by the Society:—

1. That this Society fully sympathizes with the work the Ceylon Game and Fauna Protection Society is doing for the preservation of Wild Life in Ceylon.
2. That this Society views with alarm the continued destruction of the Island's Wild Life and earnestly requests the Minister of Agriculture and Lands to make better provision for the enforcement of the existing Game and Wild Life Protection Laws for more adequate protection of the unique fauna of this Island.

The meeting terminated with a vote of thanks to Mr. Phillips.

### One Hundred and Seventeenth General Meeting

Minutes of the One Hundred and Seventeenth General Meeting of the Ceylon Natural History Society, held on 18th July, 1933.

The President, Mr. D. R. R. Burt, took the chair and forty-three members and visitors were present.

Mr. D. R. R. Burt exhibited a specimen of *Ichthyophis glutinosus* and Mr. G. M. Henry exhibited specimens of *Ancistrodon hypnale*, the hump-nosed viper.

The Very Rev. Father M. J. LeGoc delivered a lecture on 'Climate and vegetation in Ceylon'.

He said that vegetation in any part of the world is largely dependent on climate. The chief climatic factors which affect plant life or create types of vegetation are light, temperature, and atmospheric precipitations, humidity of the air, exposure, air movements and air pressure. In Ceylon, light, if anything, is excessive. Plants, though they can to a certain extent adapt themselves to different temperatures need an optimum temperature round about 30° C. Where rainfall is deficient, a high temperature is detrimental. Atmospheric precipitation mainly determines the supply of soil water. In Ceylon, rainfall is regulated by two monsoons. During the south-west monsoon, most rainfalls on the south-western part and centre of the Island, while during the north-east monsoon, the centre of condensation is close to the south-west. As regards vegetation what matters is not so much the total amount as the even distribution of rainfall.

A dry atmosphere, air movements and reduced pressure will cause excessive transpiration and are responsible for stunted vegetation, especially where the water supply from the soil is deficient.

The distribution of vegetation coincides with that of climate and different types of vegetation characterize different climatic areas or zones. In Ceylon, these are usually divided into:—

A. *Arid zone*.—Rainfall 25"-50". North of Jaffna, Mannar, Puttalam and Hambantota. In these regions we get the thorn forest, with thorny shrubs bearing small thick leaves. Grasses and herbaceous plants are rare, epiphytes and climbing plants almost absent.

B. *Dry zone*.—Rainfall 50"-75". North-Central and North-Western Provinces and also the eastern part of the Island. In this region shrubs are abundant and thorny lianas and epiphytes are found. Grasses and herbaceous plants are abundant during the brief rainy seasons. Here are characteristic plants such as satinwood, ebony, milla, iron wood, *Dipterocarpus*, *Euphorbia*, etc.

C. *Intermediate zone*.—Rainfall 75"-100". Kurunegala, Matale, Bibile. The vegetation is transitional between that of the dry and the wet zones. Lianas and epiphytes are numerous, undergrowth is more abundant, trees which belong to the dry and the wet zones are included.

D. *Wet zone*.—Rainfall over 100". This is subdivided into the up-country wet zone and the low-country wet zone. These are the regions of the Rain Forests. The low-country wet zone contains tall trees with dense foliage; epiphytes are especially abundant and jungle crowded with undergrowth. *Dipterocarps* are characteristic, also *Dilleniaceae* and *Wormia triquetra*. Epiphytes are numerous, including many orchids and among ferns, *Polypodium quercifolium* and *Drymoglossum heterophyllum*. In the up-country wet zone, the trees are smaller and young leaves are frequently coloured. Ground vegetation is extremely dense and includes *Selaginellas* and Mosses, *Marchantia*, being abundant. Tree ferns, *Cyathea* and *Alsophila* are also characteristic. Epiphytes are abundant; orchids numerous. The tree reaching highest elevation is *Rhododendron arboreum*. Many European genera are also found, e.g., *Ranunculus*, *Viola*, *Berberis*, *Rubus*, *Plantago*, etc.

The lecturer concluded by referring to plantations introduced or controlled by human agency, e.g., paddy, coconut, tea, and rubber.

## One Hundred and Nineteenth General Meeting

Minutes of the One Hundred and Nineteenth General Meeting of the Ceylon Natural History Society, held on the 17th October, 1933.

The President occupied the chair, and thirty-eight members and visitors were present.

The minutes of the previous meeting having been read and confirmed, a vote of condolence was passed on the death of Sir Graeme Thomson, the Patron of the Society.

Mr. D. R. R. Burt exhibited a specimen of *Rattus obiensis*, and Dr. W. Fernando showed lantern slides of five new Trematodes from Ceylon described by him. Dr. J. Pearson then delivered a lecture on 'Marine Biology in Ceylon'.

He first dealt with the seasonal changes in salinity and temperature, which have been revealed through an analysis of hydrographical observations made in the Gulf of Mannar. These observations have been taken for a number of years at certain

stations in the Gulf of Mannar (surface, 50m., 100m., and 300m.). During the south-west monsoon period (May-October) it was found that oceanic water of comparatively high salinity (not less than 35.25 at the surface) and low temperature (not greater than 26°C at the surface) passed into the Gulf. During the north-east monsoon (November to April) the water had a relatively low salinity (not greater than 34.50) and a high temperature (not less than 28°C).

It has been found that the spawning habits of the pearl-oyster are correlated with these seasonal changes, and that there are two spawning optima in the year, one in June-July and the other in December-January. The spawning seasons are not clear-cut and well-defined, and are in accordance with the hydrographical conditions which do not show sudden changes at any time of the year.

In contrast to these conditions, reference was made to Lake Tamblegam, a shallow, land-locked backwater of Trincomalee Harbour, with an area of nearly six square miles. Several rivers empty into the southern part of the lake, and during the wet season (November-December) large quantities of fresh water enter the lake. Consequently, the salinity of the lake shows a sudden drop as soon as the wet season begins. This sudden change from a comparatively high to an extremely low salinity in December acts as a spawning stimulus and it is found that the Window-pane oyster spawns in December-January and it is not unlikely that most animals living in the lake have their breeding season at this time of the year.

### One Hundred and Twentieth General Meeting

Minutes of the One Hundred and Twentieth General Meeting of the Ceylon Natural History Society, held on 14th November, 1933.

The President took the chair and there were present twenty-nine members and visitors.

The minutes of the previous meeting were read and confirmed.

Dr. Joseph Pearson was elected a Foreign Member of the Society in appreciation of the services rendered by him to the Society of which he was the founder.

Prof. W. C. O. Hill delivered a lecture on 'Lorisoids'. The lecturer explained that the Lorisoids are a group of primitive Primates composed of (a) the Slender Lorises of Ceylon and South India, (b) the Slow Lorises of Malaya, and (c) the Galagos and Pottos of Ethiopian Africa. The peculiar geographical distribution of the group was explained as the result of wanderings in various directions from a dispersal centre in the Sivalik Hills during the Ice Age. The Lorisoids are related to the Lemuroids, but approach the Tarsioids even more closely in several respects. They are more generalized than the true Lemurs, and are close to the main line of human evolution though not so near to that line as the Tarsioids.

The chief points about them are their nocturnal habits, large eyes, small noses, woolly coats and insectivorous diet. The Oriental forms are tailless, but the Ethiopian forms are tailed, the Galagos possessing bushy tails like the Lemurs.

The lecturer concluded by exhibiting living examples of Lemurs, Galagos and some new Ceylonese races of Lorises, descriptions of which have recently been published in the *Ceylon Journal of Science*.

Mr. D. R. R. Burt exhibited an example of twinning in the kitten.

### One Hundred and Twenty-first General Meeting

Minutes of the One Hundred and Twenty-first General Meeting of the Ceylon Natural History Society, held on the 12th December, 1933.

The President took the chair and seventeen members and visitors were present.

When the minutes of the previous meeting had been read and confirmed, Prof. W. C. O. Hill exhibited specimens of the following Australian mammals:— Jerboa Mouse (*Notomys*), Dormouse phalanger (*Dromicia*), Honey mouse (*Tarsipes*) and young; pouch embryo of Kangaroo; pouch embryo of *Perameles* and Pouched Mouse (*Sminthopsis murina*).

Dr. J. P. C. Chandrasena then delivered a lecture on 'Colouring Matters, Natural and Synthetic'.

The lecturer pointed out the considerable part the quest of luxuries has played in the migrations of human races and in the spread of civilizations. By way of example, he cited the influence of the search for raw material for the manufacture of perfumes and spices as it affected Ceylon.

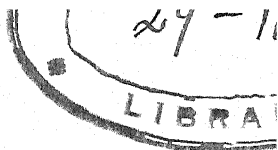
After explaining the difference between dyes and stains, he said that the earliest known dyes would belong to that class known as vat dyes, that is, those which are colourless when fresh but are oxidized by atmospheric oxygen to coloured substances. Two members of this class most important in History are tyrian purple and indigo. The former is obtained from a certain kind of Mollusc found in the Mediterranean, and the latter from the indigo plant, which grows in India. The lecturer then dealt with the synthesis of mauveine by Sir William Perkin and the chemical investigations which followed, culminating in the foundation of the synthetic dye industry. Special mention was made of Adolf von Baeyer's investigations which resulted in the manufacture of indigo naphthalene.

An account was next given of the recent work on the carbocyanine dyes which have made infra-red photography possible.

The part played by dyes in the amenities of modern life and the application of dyes in biological experiments were also mentioned in brief.

*All blocks illustrating this Part by courtesy of the Survey Department, Ceylon.*





## Two New Reptilian Cestodes of the genus *Proteocephalus* (*Ophiotaenia*)

BY

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(With Eight Text Figures)

### ***Proteocephalus* (*Ophiotaenia*) *phillipsi*, sp. nov.**

This cestode was found in the intestine of the Green Pit Viper or Green Tic, *Trimeresurus trigonocephalus* (Daudin), a snake peculiar to Ceylon and found commonly above 3,000 feet. Over a dozen snakes were examined, all collected by Mr. W. W. A. Phillips at Mousakande, Gammaduwa, and all except two were infested with the same cestode. In two snakes only a single cestode was found, but in others the number was as high as 25 and 34.

### DESCRIPTION

*External.* The worms vary in length, mostly from 400 to 850 mm. (one specimen is 920 mm.) but it is only in the longer specimens that gravid proglottides are obtained. The breadth varies from 1.5 to 2.1 mm. These measurements do not take into account many immature worms some of which were as short as 22 mm. The anterior proglottides, as is usual, are many times broader than long, but at a distance of from 90 to 110 mm. from the scolex the length of each proglottis is about equal to its breadth, while posterior to this the proglottides increase in length, until in mature proglottides the length may be five to six times the breadth. The ratio of length to breadth was found to vary in mounted specimens, owing to contraction during clearing, so that measurements were taken of the living worms, and of worms after fixation but before clearing. The proglottides are broadly attached, and the strobila is remarkably uniform in diameter throughout, presenting a very uniform straight lateral margin, except



in the more mature proglottides where the cirri protrude. In the mature and gravid proglottides a deep groove runs along the mid ventral line.

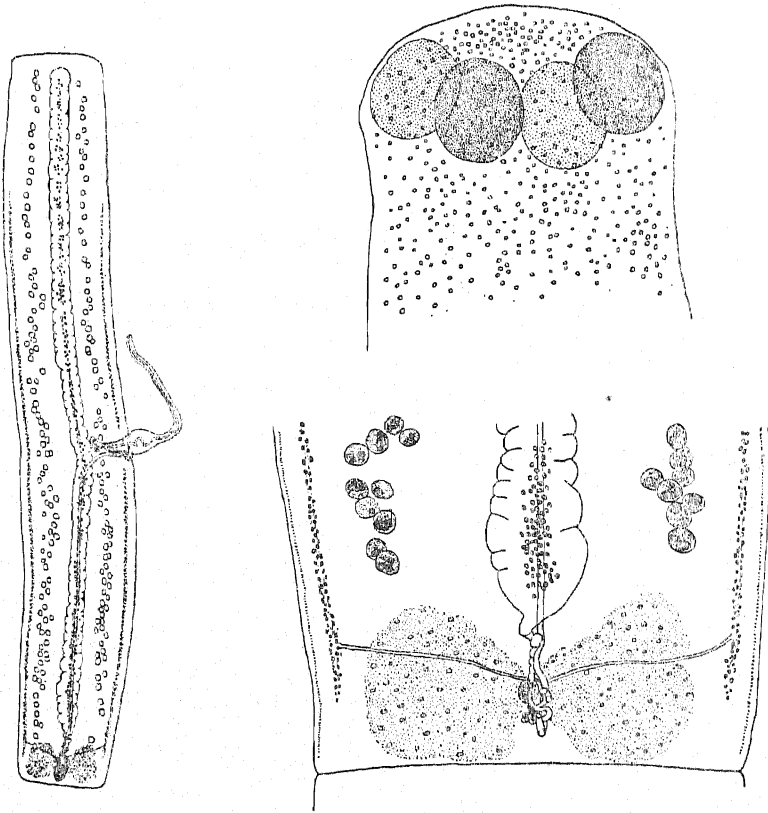


Fig. 1. *Proteocephalus (Ophiotaenia) phillipsi*, sp. nov.

Scolex  $\times 48$ , Mature proglottis  $\times 12$ , Female genital organs  $\times 48$ .

In the accompanying graph (Fig. 2) the proglottides are plotted in sequence against their length and breadth, and the curves obtained are true for this species. The two curves of breadth and length give at a glance the ratio of these two measurements in any given proglottis. In addition the length curve is to be regarded as the growth curve, for new proglottides are formed at the anterior region of the strobila, and move posteriorly as they increase in age and, presumably, each new proglottis is of approximately the same length. To simplify the graph, measurements of every 20th proglottis are shewn.

Approximately rectangular proglottides are found (165—175), in which region the genital strand is sufficiently developed to indicate on which side the cirrus will open. In the region of proglottis 260, the lumen of the uterus becomes patent and the primordia of the testes are easily recognized, while after full growth is obtained, proglottides 280—290, ova are seen in the uterus, and the proglottides may be regarded as gravid.

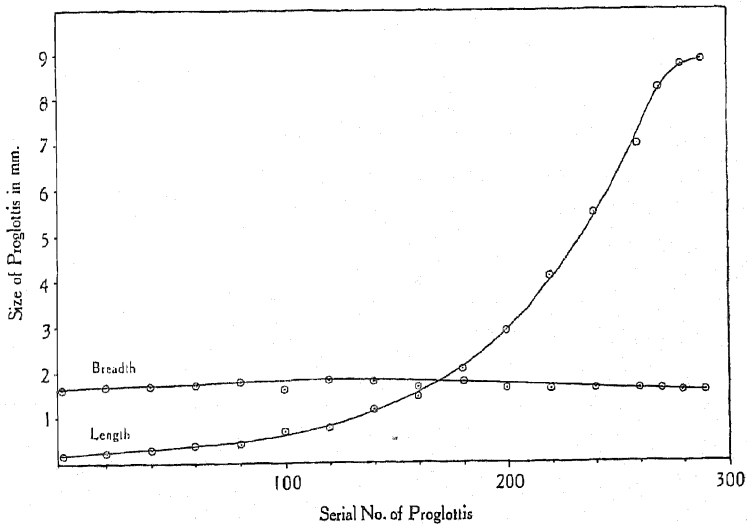


Fig. 2. *Proteocephalus (Ophiotaenia) phillipsi*, sp. nov.

Graph showing ratio of length to breadth at different regions of strobila.

The scolex is unarmed. It varies in size, the diameter shewing a close correlation to the length of the worm, provided the worm is complete with terminal proglottis. The diameter of the scolex is  $670\mu$  in a worm 22 mm. long,  $1,000$  in a worm 250 mm. long, and  $1,400\mu$  in one of 400 mm. length. There are four unarmed round suckers, entire in outline and with shallow cavities. Their diameter varies from  $200\mu$  in a worm 22 mm. long, to  $310\mu$  in a worm of 500 mm. length. The fifth apical sucker, of some *Proteocephalidae*, is not found, it cannot even be described as vestigial or rudimentary, for sections through the scolex show no trace of it. A slight concentration of the parenchyma which is present at the apex of the scolex cannot be interpreted as a rudimentary sucker. The suckers are sessile, but in the live worm the scolex shows much muscular movement, the suckers being protruded forward in pairs alternately,

right dorsal and left ventral sucker together, then left dorsal and right ventral suckers. There is no demarcation between the scolex and the neck which extends up to 6 or 7 mm. from the anterior limit of the scolex.

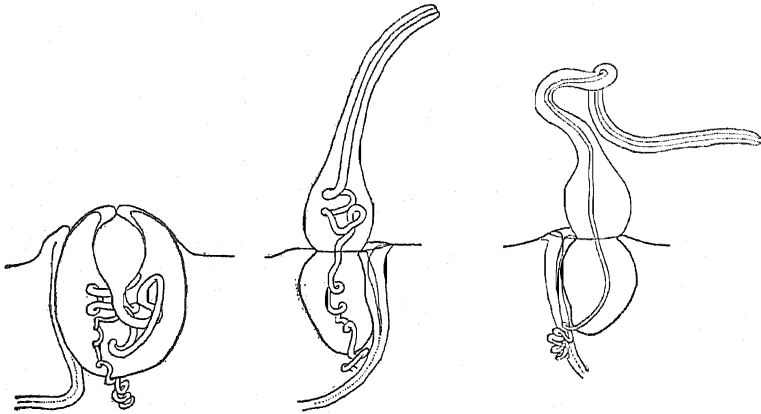


Fig. 3. *Proteocephalus (Ophiotaenia) phillipsi*, sp. nov.

Eversion of cirrus  $\times$  circa 40.

*Male genitalia.* There are from 170 to 230 testes, arranged in two lateral fields, the central area being entirely free. A few testes may overlap the ovary on either side posteriorly, but there are no testes posterior to the ovary. The testes are more numerous in the aporal field where they number from 90 to 120, while porally they number 80 to 110. The poral field is interrupted by the cirrus, vagina and vas deferens, and it is constantly found that the number of testes lying posterior to the cirrus in the poral field is greater than that anterior to it. The testes are spherical vesicles measuring from 85 to 108  $\mu$  in diameter. The vas deferens is a stout, much convoluted tube, passing above the ventral longitudinal excretory vessel, and as the ductus ejaculatorius, it enters into the cirrus sac. The cirrus sac is sometimes anterior, and sometimes posterior to the vagina, but the latter condition is more usual. The cirrus sac varies in size according to the degree of protrusion of the cirrus. Where the cirrus lies within the cirrus sac, the latter is distended and may measure more than half the breadth of the proglottis. Where the cirrus is protruded, the length of the sac is from  $\frac{1}{3}$  to  $\frac{1}{4}$  the breadth of the proglottis. The condition generally found in gravid proglottides is the protruded cirrus,

but the degree of protrusion varies from proglottis to proglottis. The mechanism of the protrusion may be seen in fig. 3. Where the cirrus lies completely within the sac it is swollen, and contains the coiled ejaculatory duct and the cirrus in an involted condition with its base continuous with the external lips of the cirrus sac. As the walls of the cirrus sac are muscular, protrusion would appear to be effected by contraction of the muscular coat, the resulting high hydraulic pressure within the sac causing the cirrus to be everted and protruded. In this condition the ductus ejaculatorius passes straight through the sac but coils are present in the base of the cirrus. Further eversion of the cirrus utilizes the coiled ductus ejaculatorius which is now a straight tube passing through cirrus sac and cirrus. The cirrus is therefore a double walled tube, the outer tube continuous distally with the inner tube which extends inwards as the ductus ejaculatorius through the cirrus sac.

The following measurements give an idea of the variability of this organ:—

Cirrus sac		Cirrus
length	breadth	length
545 $\mu$	382 $\mu$	involted
368 $\mu$	250 $\mu$	3,030 $\mu$
370 $\mu$	147 $\mu$	1,400 $\mu$

The length of the cirrus sac is a character which can be taken as fairly constant, provided that the cirrus is protruded. This length falls within the limits 360—380  $\mu$ . The cirrus is pear-shaped, and the breadth of the widest part towards the base is likewise a fairly constant character varying from 260 to 310  $\mu$ . The difference in degree of eversion of the cirrus may not be attributed to methods of fixation, as the worms were studied alive. This point is emphasized as the length of the cirrus is given for some worms as a diagnostic character. The cirrus is only protruded in older mature and gravid proglottides, where it is rare to find the involted condition.

*Female genitalia.* The ovary is butterfly-shaped, lying in the extreme posterior region of the proglottis. The two sides are connected by a narrow transverse isthmus 44  $\mu$  in diameter, on the ventral side of which is a well developed "Schluckapparat" at the origin of the oviduct. The "Schluckapparat" is an approximately spherical chamber 82  $\mu$  in diameter, its walls are strongly muscular and surrounded by a single layer of large glandular cells, and from it leads the oviduct. The oviduct runs backwards to the posterior limit of the proglottis where it bends dorsally and forwards, and after a few convolutions in its course unites with the vagina and the common duct

enters the shell gland. The vagina arises in the middle of the proglottis in the genital atrium and passes directly inwards to the mid line where it turns posteriorly lying dorsal to the uterus. In immature proglottides the peripheral transverse limb of the vagina lies usually posterior to the cirrus, in mature proglottides the position is variable. The vagina, towards the region of the ovary, comes to lie ventral to the uterus, and it passes backwards, dorsal to the ovarian isthmus after which it is twisted into a few convolutions before uniting with the oviduct a short distance before the common duct enters the shell gland. Peripherally the vagina is wide, with muscular walls associated with glandular cells, and provided with a sphincter vaginae, but in the longitudinal region the duct is uniformly about  $50\mu$  wide. There is no region of the vagina specialized as a receptaculum seminis.

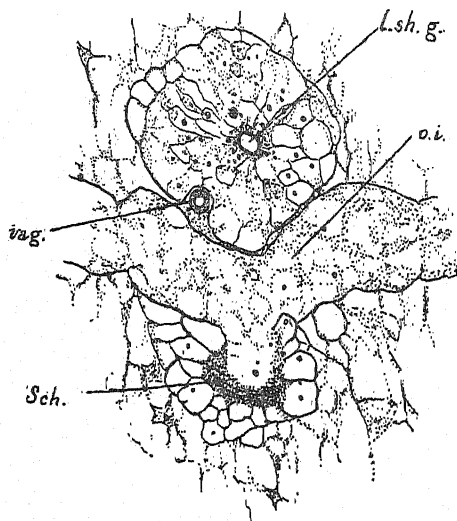


Fig. 4. *Proteocephalus (Ophiotaenia) phillipsi*, sp. nov.

Transverse section passing through "Schluckapparat"  $\times 250$ . o.i., ovarian isthmus; l.sh.g., lumen of shell gland; Sch., Schluckapparat; vag., vagina.

The vitelline glands are situated laterally close to the lateral margin of the proglottis and extend along practically the whole length of the proglottis. On each side there is a longitudinal vitelline canal into which open the vitelline follicles, and from this canal the vitelline duct arises posteriorly on a level with the anterior limit of the shell gland. The ducts pass medially to unite aporally near the mid line.

The common vitelline duct runs posteriorly to the aporal side of the oviduct, turns dorsally, and after enlarging into a reservoir opens into the shell gland on its posterior face just dorsal to the opening of the united oviduct and vagina. The shell gland lies dorsal to the ovarian isthmus and measures  $112\mu$  in breadth. From the shell gland the uterus continues anteriorly, at first narrow but expanding and giving off many diverticula, and occupying the whole length of the proglottis in front of the ovary. There arise from 60 to 80 diverticula on each side of the uterus. There is a longitudinal groove in the mid ventral line of the proglottis where the external layers of the cortex are in close proximity to the wall of the uterus, and in advanced proglottides the uterus is open to the exterior throughout the extent of this groove. But few proglottides were found in this condition and all were separate from the strobila, so that it is assumed that they were shed before dehiscence of the ova. The uterine opening is not preformed but only appears when the uterus is full.

The ovum is provided with two envelopes; it measures  $30 \times 24\mu$ . The onchosphere measures  $14\mu$  in diameter.

*Parenchyma and muscles.* The cuticle is a darkly staining homogeneous layer beneath which lies first a thin layer of circular muscles and then an equally thin layer of longitudinal muscles. Internal to this is a layer of subcuticular cells containing spindle-shaped cells and conspicuous ovoid and spherical cells  $10-14\mu$  in diameter, with deeply staining nuclei  $4\mu$  in diameter. The worms show very feeble muscular movements when alive. The parenchyma is very loosely meshed showing large intercellular spaces. There is no sharp demarcation of the parenchyma into cortex and medulla, but a very diffuse thin sheet of longitudinal fibres, nowhere collected into bundles, can be identified in sections from the neck and anterior regions of the worm. In mature proglottides it cannot with certainty be made out, but traces of it can be identified just external to the vitellaria. In thickness the external region of the parenchyma (the cortex), measures about  $1/18$ th of the breadth of the worm. Whether this diffuse internal layer of longitudinal muscles separate the parenchyma into cortex and medulla, it is certain that no part of the genital system extends into the cortex.

*Excretory system.* In the anterior region of the neck and in the scolex, four excretory canals are apparent, uniting in a ring internal to the suckers. Throughout the strobila only the ventral canal can with certainty be identified. The ventral canal, a thin walled tube, seldom of greater diameter than  $14\mu$ , branches frequently, some of the

branches reunite, some terminate in spaces in the parenchyma, while others show openings to the exterior through the cuticle—the 'foramina secundaria' of some authors. The vagina and cirrus pass dorsal to the ventral excretory canal.

*Abnormalities.* Abnormal proglottides were not uncommon, they generally took the form of duplication of one or more parts of the genital system. The following conditions were observed. Two cirri present in one proglottis, either on the same or opposite sides. Both were fully formed but it was not determined whether both were functional. The vagina was also duplicated in some cases where there was duplication of the cirrus. One of the two vaginae might end blindly, the other being normal, or both might be connected to a common vagina.

The abnormal proglottides were always observed towards the posterior end of the strobila, more especially when the original terminal proglottis was present. The original terminal proglottis was often abnormal itself, being at a much earlier stage of development than the preceding proglottides.

*Intermediate host.* The intermediate host is not known. The intestinal contents, which could be identified, were hairs of small furry animals, which were thought to be either rodents or shrews. Laboratory rats and mice were fed with ova from gravid proglottides but no cysticerci were recovered. Mr. W. W. A. Phillips however informs me that tree frogs and lizards may also form part of the diet of these snakes.

It is considered that the species here described is a new one, and it is named *Proteocephalus (Ophiotaenia) phillipsi*, after W. W. A. Phillips, Esq., F.L.S., in grateful appreciation of much assistance in procuring specimens, and particularly in this instance in collecting the snakes which made this study possible.

### *Synopsis of Diagnostic Characters*

#### ***Proteocephalus (Ophiotaenia) phillipsi*, sp. nov.**

*Host:* *Trimeresurus trigonocephalus* (Daudin).

*Locality:* Gammaduwa, Ceylon.

*Size:* 400 to 920 mm. long by 1.5 to 2.0 mm. broad.

*First proglottides* much broader than long; length : breadth : : 1 : 8-10.

Mature proglottides much longer than broad; length: breadth: 5-6: 1.

Scolex muscular; diameter 670-1,400  $\mu$ .

Suckers round; diameter 250-310  $\mu$ .

Fifth sucker not present.

Genital aperture situate about centre of lateral margin.

Cirrus sac: 260—280  $\mu$  long by 145—260  $\mu$  broad where cirrus is not involuted, 1/4 to 1/3 breadth of proglottis.

Cirrus when fully protruded long and slender with swollen base; length 3.03 mm.

Ductus ejaculatorius coiled or straight according to everted condition of cirrus.

Testes: 170—230, 85 to 108  $\mu$  in diameter, arranged in two lateral fields. Aporally 90—120, porally 80—110, more numerous on poral side posterior to cirrus sac than anterior to it.

Vagina anterior or posterior to cirrus sac.

Uterus: 60—80 diverticula on each side, opens to exterior in fully gravid proglottides by mid ventral opening extending the length of the proglottis.

Ovum: 30  $\times$  24  $\mu$ , with two envelopes, onchosphere 14  $\mu$  in diameter.

Excretory canal: ventral excretory canal only recognizable, passes ventral to genital ducts.

#### DISCUSSION

Up to the present no cestode has been described from the Green Pit Viper *Trimeresurus trigonocephalus*, but several cestodes are known from allied genera of Crotaline snakes. Parona (1898) described *P. trimeresurus* from *Lachesis sumatranus* (syn. *Trimeresurus formosus*) found in the Island of Mentawai in the East Indies. Parona's species measured 10.5 cm. long by 0.75-1.5 mm. broad at the widest part, but it had no fully ripe proglottides, so it has to be decided whether his species is an immature form of the new species *P. phillipsi*. The point is definitely settled by comparing *P. trimeresuri* with immature forms of *P. phillipsi*, selecting specimens of the latter of appropriate length. In *P. phillipsi* of 10.5 cm. there is no trace in the posterior proglottides of the reproductive organs, apart from a concentration of cells constituting the primordia of the genital strand, and even in *P. phillipsi* 17.0 cm. long the cirri are not developed although they are



described by Parona in his species. One would not, as a rule, place much reliance on evidence of length as a diagnostic character, as great contraction and shortening may occur during fixation of the worm. But in the case of *P. phillipsi*, where the musculature is extremely feeble, it was found that contraction was slight even with reagents which kill and fix slowly. This fact, by the way, accounts for the very smooth growth curve, and I have no hesitation in using the character of length as a diagnostic one, particularly when accompanied by details of the state of development of the posterior proglottides. It is obvious also from Parona's figures that the two worms are specifically different and that, even when fully gravid, *P. trimeresuri* must be a very much smaller worm.

The other cestodes which need to be considered are *P. viperis*, from *Lachesis alternans*, *P. naiae* from *Naia tripudians*, *P. russelli* from *Vipera russelli* all described by Beddard (1913) from Indian snakes. The following New World cestodes also show certain affinities to *P. phillipsi*, *P. marenzelleri* (Barrois) 1898, *P. grandis* (La Rue) 1911, and *P. agkistrodontis* Harwood 1933, all from *Ancistrodon piscivorus*.

Beddard's two Indian species from the Cobra and Russell's Viper are apparently allied to *P. trimeresuri* and these three species are grouped together by Rudin (1917). Beddard's descriptions are lacking in detail of diagnostic characters, and the only characters that can be deduced from his description of *P. naiae* are that the length of the worm is 110 mm., ripe proglottides are twice as long as broad, the fifth sucker is absent and uterine pores are present. Woodland (1925) has fortunately re-described *P. naiae*, and from his description it is evident that *P. phillipsi* is a much larger worm with larger scolex, more numerous testes, more numerous uterine pouches and larger ova. The characters of *P. russelli* are a length of 30 cm., a breadth of 2-3 mm., and the absence of a definite sphincter vaginae. The size of the scolex is given as not more than half that of *P. gabonica* (Beddard) 1913, found in *Bitis gabonica* in Africa. The size of the scolex of *P. gabonica* is given as intermediate between that of *P. naiae* (Beddard) and that of *Crepidobothrium gerrardi* (Baird), which is known to vary from 0.93 to 1.75 mm. Utilizing Woodland's measurements of the scolex of *P. naiae* (Beddard gives none for *P. gabonica* nor for *P. naiae*), we find that the scolex of *P. russelli* cannot exceed 0.59 mm. The text figures of *P. russelli* indicate that it differs from *P. phillipsi* in having a smaller ratio of length to breadth in proglottides showing the same stage of development, in having fewer testes, a smaller number of uterine diverticula and in the number of uterine pores. *Proteocephalus*

*viperis* described as *Solenotaenia viperis* by Beddard (1913), from *Lachesis alternans*, the Crossed Viper on account of the fact that the uterus opens to the exterior by a median longitudinal slit, a character shared with *P. phillipsi*, is a much smaller cestode than the latter. Individuals of *P. viperis* shewing gravid proglottides with the slit opening of the uterus are 130-150 mm. long. This cestode is described as having a fifth apical sucker, though the figures of the sections demonstrating the presence of this sucker are not convincing. Beddard's figures show that mature proglottides of *P. viperis* are barely twice as long as broad, that there are about 144 testes and only about 35 diverticula of the uterus on each side, which evidence supports the view that *P. phillipsi* is not identical with *P. viperis*.

*P. marenzelleri* has a larger scolex, relatively larger suckers, relatively shorter mature proglottides, smaller testes and fewer uterine pouches than *P. phillipsi*. *P. grandis* described from fragments, is a much broader worm with larger suckers than *P. phillipsi*. The number and size of testes is approximately the same in both cestodes, but the number of uterine pouches is smaller in the former. The cirrus of *grandis* is characteristic, for, when fully extended, *i.e.*, with no coils of the ductus ejaculatorius in its base, it is a short and heavy organ, while in *P. phillipsi* in a fully protruded condition it is exceedingly long and slender measuring about twice the breadth of the proglottis. One other differentiating character is that there are 2-8 uterine pores in *P. grandis* and not a longitudinal slit as in *P. phillipsi*.

*P. phillipsi* is separated from *P. agkistrodontis* as the latter cestode has fewer and smaller testes (90-110, 35-75  $\mu$ ) a smaller cirrus sac, and fewer uterine pouches (25-30) and the genital pore is situated relatively farther forward, but in many other respects the two cestodes are similar particularly in the size of the scolex and suckers, and in the mid-ventral slit opening of the uterus.

### ***Proteocephalus (Ophiotaenia) rhabdophidis*, sp. nov.**

The following description is of a new cestode found in the intestine of *Rhabdophis stolata* (Linn. 1758), taken near Avissawella, W.P. Ceylon. Two specimens of this cestode were obtained.

*External.* When alive the worms measured about 250 mm. in length, but during fixation in Bouin's fluid a slight contraction took place and some of the terminal proglottides broke off as in *Proteocephalus phillipsi*. The terminal proglottides of both specimens are gravid. The greatest

breadth of the worms is 1.2 mm. The ratio of breadth to length of mature proglottides is 1: 2—3, and of gravid proglottides 1: 2—4. Strobilisation is distinct.

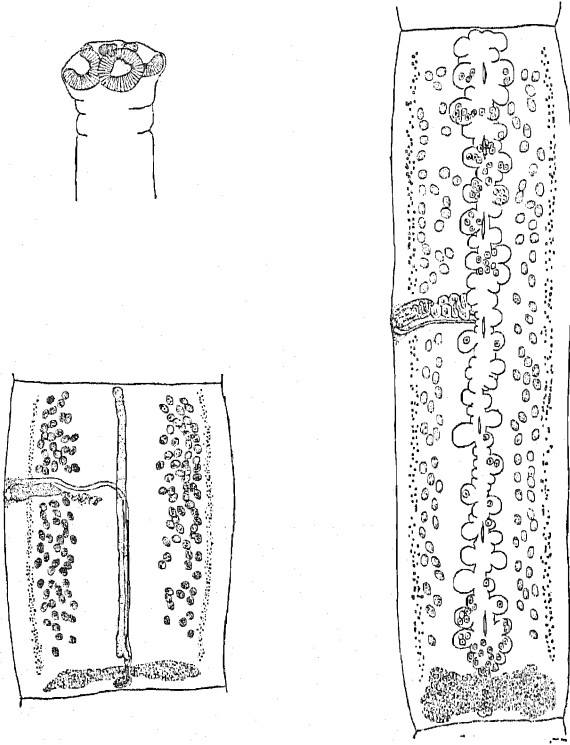


Fig. 5. *Proteocephalus (Ophiotaenia) rhabdophidis*, sp. nov.

Scolex  $\times 73$ , Mature proglottis  $\times 28$ , Gravid proglottis  $\times 28$ .

The scolex measures  $187\mu$  in diameter and about  $130\mu$  long. It is devoid of cuticular hooks. There are four suckers measuring  $102\mu$  in diameter, and a fifth apical sucker or rostellum measuring  $51\mu$  in diameter and  $41\mu$  long. The suckers are round in outline and directed anteriorly, lying close together. The neck extends for 5 mm. from the anterior end of the scolex, and its breadth increases from  $156\mu$  to  $620\mu$ , the latter measurement being taken just anterior to the region

where strobilisation begins. The following table gives the size of proglottides at various points throughout the length of the strobila.

Breadth in $\mu$	Length in $\mu$	Region
620	60	most anterior proglottides
800	190	first appearance of genital strand
970	410	ovary apparent
1,020	620	testes apparent
1,200	2,210-2,510	mature proglottides
650	3,350	gravid proglottides

These measurements may not be accepted as absolute, owing to the greater contraction and consequent greater breadth of some regions of the strobila.

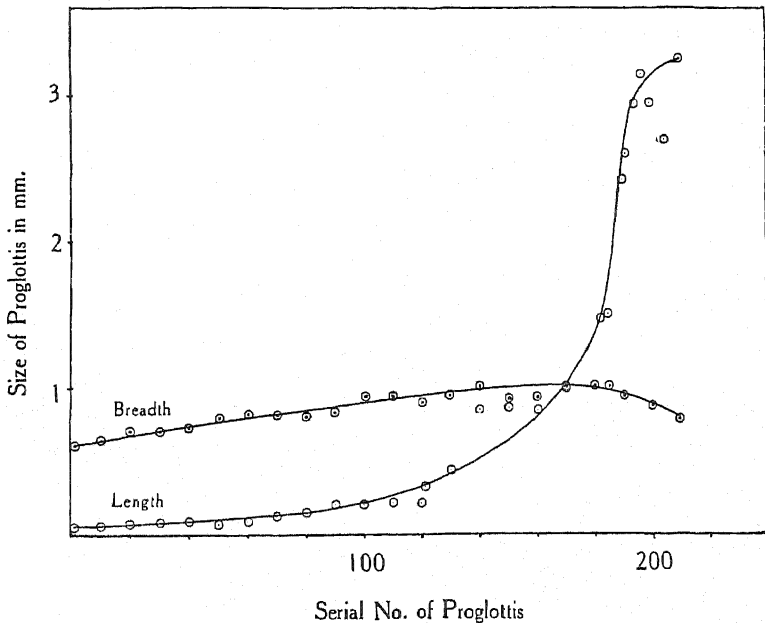


Fig. 6. *Proteocephalus (Ophiotaenia) rhabdophidis*, sp. nov.

Graph showing ratio of length to breadth at different regions of strobilis.

The accompanying graph (Fig. 6) obtained in the same way as the graph for *P. phillipsi*, but drawn with a greater scale on the vertical axis, shows a less close agreement of the observed values to a smooth curve. It is obvious from the fact that contraction is not uniform in all parts of this worm during fixation that irregularities must occur, and as this cestode possesses a much stronger musculature than *P. phillipsi* the irregularities must be greater. It is seen however that for the most

part a greater breadth of the strobila due to shortening of the proglottis is accompanied by a decrease in length. In gravid proglottides the irregularities are great.

The length curve of this graph, representing the curve of growth in length, is similar to that of *P. phillipsi*, and it shews in its relation to the breadth curve the difference in the ratio of length to breadth. It is thought that such curves, expressed algebraically, might furnish an expression with some factor which is constant for each species. Such a factor would be a useful diagnostic character. It is not, however, proposed to go more fully into this aspect of these curves in the present paper, as I have not yet obtained a sufficient number of *Proteocephalids* to warrant conclusions being drawn from their growth curves.

*Male genitalia.* There are from 110 to 140 testes, of which 56 to 70 are paracirrus, and 55 to 70 are acirrus. They are situated in two definite lateral fields and may extend lateral to the longitudinal canals although lying in the medulla. The terminal region of the vas deferens is much coiled and swollen and contains sperms, apparently functioning as a seminal vesicle. It lies immediately median to the cirrus sac and extends almost to the middle of the proglottis. In no proglottis is the cirrus found to be protruded. It lies in the cirrus sac with the much coiled ductus ejaculatorius at its base and partially surrounding it. The cirrus sac measures from 147 to 250  $\mu$  in length, and 63 to 88  $\mu$  in breadth. The ratio of length of cirrus sac to breadth of proglottis is 1: 4-5. The cirrus sac opens into the genital atrium which also receives the vagina. The genital atrium is situated between the centre of the lateral margin of the proglottis and the posterior end of the anterior third of it. The aperture of the genital atrium is minute and is provided with a sphincter muscle. The genital strand first becomes apparent as a transverse thickening in the medulla to one side of the mid line, at 17 mm. from the anterior end of the worm. Five mm. posterior to this region the genital strand has extended to the posterior end of the proglottis, and the testes are distinctly recognizable 30 mm. from the anterior end.

*Female genitalia.* The ovary is situated in the extreme posterior region of the proglottis. It is bilobed, and in young proglottides is narrow and transverse, extending almost to the limits of the medulla, while in mature and gravid proglottides it becomes broader extending anteriorly in the proglottis, each moiety becoming slightly lobate. The two ovarian lobes are connected by a narrow transverse isthmus, which opens through a well-developed 'Schluckapparat' 55  $\mu$  in diameter, into the oviduct. The vitellaria are conspicuous, forming a band on

either side of the proglottis varying from 50 to 70  $\mu$  in breadth. The vitellaria lie just median to the longitudinal muscle layer, and extend almost the whole length of the proglottis, being absent posteriorly in the region lateral to the ovary. On each side there is a conducting tubule into which open the vitelline follicles, the latter measuring 10-15  $\mu$  in diameter. On each side a vitelline duct arises towards the

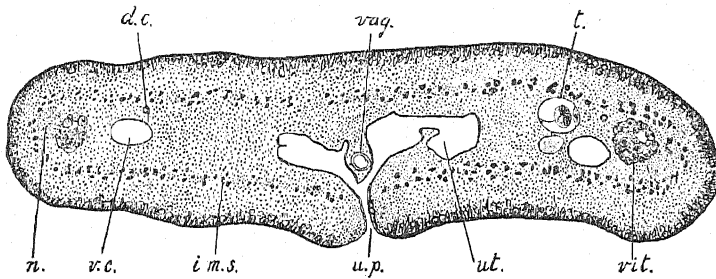


Fig. 7. *Proteocephalus (Ophiotaenia) rhabdophidis*, sp. nov.

Transverse section of gravid proglottis  $\times 110$ . d.c., dorsal excretory canal; i.m.s., inner longitudinal muscular layer; n., lateral nerve; t, testes; ut, uterus; u.p., uterine pore; vag., vagina; v.c., ventral excretory canal; vit., vitellaria.

posterior end of the gland, and the two ducts pass medially to unite and enter the shell gland. The uterus extends from the shell gland, which lies dorsal to the ovarian isthmus to the anterior limit. It is provided with from 30 to 45 lateral diverticula on each side, and opens to the exterior in the mid ventral line through 7-9 uterine pores. The uterus becomes hollow 74 mm. from the anterior end, and the most anterior proglottis in which the uterus contains ova is 91 mm. from the anterior end. The first proglottis in which all the ova have been extruded from the uterus through the uterine pores is 230 mm. from the anterior end. Posterior to this region the proglottides become detached easily. The eggs measure 24-27  $\mu$  in length, and 22-24  $\mu$  in breadth. The embryos measure 13.5  $\mu$  in diameter.

*Muscular system.* The internal longitudinal muscles are well-developed and form a distinct layer separating the cortex from the medulla. There are scattered dorso-ventral muscles, and a few circular muscles, but the latter do not form a distinct layer. In the scolex the longitudinal muscles converge and are attached to the basement membrane of the suckers.

*Excretory system.* The excretory canals consist of a wide ventral longitudinal canal and a very small dorsal excretory canal. The ventral canals are sinuous, and frequently branch into smaller vessels which reunite. There is no transverse canal connecting the ventral vessels on either side (Fig. 8). The genital ducts pass between the dorsal and ventral canals, and ventral to the lateral nerve.

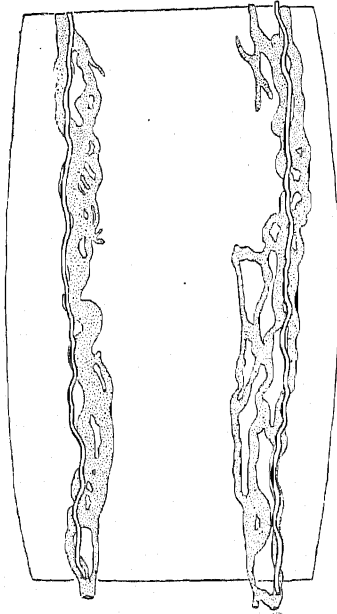


Fig. 8. *Proteocephalus (Ophiotaenia) rhabdophidis*, sp. nov.

The arrangement of the longitudinal excretory canals, reconstructed from serial sections  $\times 48$ . The greater branching of the ventral canal is on the poral side.

*Intermediate host.* The intermediate host is not known. *Rhabdophis stolata* feeds mainly on *Bufo melanostictus* the commonest Ceylon toad, but no cysticerci have so far been obtained from this toad.

This cestode is believed to be a new species and is named *Proteocephalus (Ophiotaenia) rhabdophidis*.

#### DISCUSSION

Two species of *Proteocephalus* have been described from *Rhabdophis stolata*, *Proteocephalus fixus* Meggitt 1927, and *Proteocephalus fima* Meggitt 1927. Of these two worms the length of the latter is not

known and the scolex of the former was not found. The accompanying table shows the differences between these two species so far as the published descriptions go, and the new species.

	<i>P. fima</i>	<i>P. fixus</i>	<i>P. rhabdophidis</i>
Strobila—length	not known	50 mm.	240–260 mm.
breadth	1.0 mm.	1.5 mm.	1.2 mm.
Neck	—	not known	5 mm. long by 156–620 $\mu$ broad
Ratio. breadth : length	—	—	620 : 58 $\mu$
First proglottides	—	—	1,286 : 2.21–2.5 mm.
Mature proglottides	—	—	0.65 : 3.35 mm.
Gravid proglottides	longer than broad	longer than broad	(1 : 4–5)
Scolex	200 $\mu$ diameter unarmed	not known	187 $\mu$ diameter unarmed
Suckers	not given	not known	102 $\mu$ diameter
Fifth sucker	absent	not known	51 $\mu$ broad by 41 $\mu$ long
Genital pore	a little anterior to centre of lateral margin	centre of lateral margin except in gravid proglottides in anterior third	between posterior limits of anterior third and centre of lateral margin
Cirrus sac	—	—	147–250 $\mu$ long 66–88 $\mu$ broad
Length cirrus sac : breadth proglottis	—	—	1 : 6–8
Ductus ejaculatorius	—	—	much coiled
Vesic. sem.	—	—	terminal part of vas swollen and convoluted
Testes number	68–89	71–94	115–140
aporal	33–54	40–50	55–70
poral	30–40	31–50	56–70
Testes arrangement	Two lateral fields	Two lateral fields	Two lateral fields
	Extend lateral to excretory canals	Do not extend lateral to excretory canal	Extend lateral to excretory canals
Relation of vagina to cirrus sac	Usually anterior	Usually anterior	Usually anterior
Eggs size	—	—	24–27 $\mu$ long 22–24 $\mu$ broad
Embryos size	—	—	13.5 $\mu$ in diameter
Uterine pouches	27–33	20–24	30–45
Genital ducts	Between exc. vessels.	Between exc. vessels	Between exc. vessels ventral to nerve 7–9
Uterine pores	—	—	

The new species can be differentiated at once from *P. fima* for the scolex of the latter is known and it does not possess the fifth apical organ or sucker, also the number of testes is definitely and significantly greater in the new species. The two worms *P. fima* and *P. fixus* have much in common, but can apparently be differentiated by one character only, the number of uterine diverticula. The greater breadth of the strobila may not be accepted as a valid means of differentiation, and



the number of testes 68—89 in *P. fima* is to all intents and purposes identical with the number 71—94 in *P. fixus*. If the scolex of *P. fixus* were known, one might be more certain with regard to the separate identity of these two species, but the fact that both were described by Meggitt in the same year lends strong support to their being separate species. The number of uterine diverticula in the new species although definitely greater than that of *fixus* is only moderately greater than that of *fima*, and the number of testes in *P. rhabdophidis* is definitely greater than the number in either of the other two species. It is unfortunate that the ratio of length to breadth in mature and gravid proglottides is not given in *fixus* and *fima*, but this character is not actually essential to establish *P. rhabdophidis* as a new species, for it has the fifth apical sucker which differentiates it from *fima*, and in respect of the number of testes and uterine pouches it is definitely different from *fixus*. In other words with regard to the known characters, *fixus* and *fima* are more nearly related to one another than to *P. rhabdophidis*.

On these grounds then I describe this as a new species, naming it after the type host, *Rhabdophis stolata*.

#### THE CHARACTERS AND SYNONYMY OF THE GENUS PROTEOCEPHALUS (OPHIOTAENIA)

There exist at present divergent opinions concerning the validity of the generic name *Proteocephalus* and the diagnostic characters which separate the different genera of the Proteocephalidae.

In 1858 Weinland erected the genus *Proteocephalus* and named as the type of this genus *Taenia ambigua* Dujardin 1845. *Taenia ambigua* and *Taenia filicollis* Rudolphi 1802 are considered as synonyms by some workers, but doubt on this point only affects the name of the type, for both worms belong indisputably to the same genus. The validity of the name *Proteocephalus* has been questioned, on account of the fact that thirty years before Weinland erected the genus, Blainville used the name *Proteocephala* (1828) for the group of worms containing *Caryophylleus* Gmelin 1780. Meggitt (1914 and 1927), Fuhrmann, and Ariola (1899) maintain that the genus *Proteocephalus* is pre-occupied by *Proteocephala* Blainville, and thus invalidated, but Article 36 of the International Rules of Zoological Nomenclature, and the Recommendation with regard to that Article do not substantiate this view. The Article states: 'Rejected homonyms can never be again used . . . ' and the Recommendation states 'It is well

to avoid the introduction of new generic names which differ from generic names already in use only in termination or in a slight variation in spelling which might lead to confusion. But when once introduced such names are not to be rejected on this account. Examples: *Picus*, *Pica* . . .', which example is of the same order as *Proteocephalus*, *Proteocephala*. *Proteocephalus* is therefore valid, and being the first genus to be described in this family gives validity to the family name Proteocephalidae.

In 1894 Lönnberg erected the genus *Ichthyotaenia* to contain the species described by Rudolphi (*T. filicollis*). The genus *Ichthyotaenia* is therefore a synonym for *Proteocephalus*.

La Rue (1911) defined the family Proteocephalidae, and included in it six genera: *Proteocephalus* Weinland, 1858, *Choanoscolex* La Rue (1911), *Corallobothrium* Fritsch 1886, *Crepidobothrium* Monticelli 1899, *Acanthotaenia* von Linstow 1903, and *Ophiotaenia* La Rue 1911. The cestodes described in this paper agree with the generic definition of *Ophiotaenia* La Rue, which is as follows: 'With characters of the family. Head globose or somewhat tetragonal. No rostellum. No hooks or spines. Suckers circular or oval, with margins entire. Fifth sucker vestigial. Neck usually long. Testes in two lateral fields anterior to the ovary. Vagina anterior or posterior to the cirrus-pouch. Ovary bilobed, flattened, sometimes alate. Parenchyma with fine meshes. Musculature weak. Habitat: in aquatic snakes, Crotalinae, Colubrinae, Elapinae, and Amphibia. Type species: *Ophiotaenia perspicua* La Rue 1911.' The difference between the type genus *Proteocephalus* Weinland as redefined by La Rue (1911), and *Ophiotaenia*, may be summed up in that the former genus, parasitic in fishes, has a well developed musculature and the testes in a broad field, and that the latter genus, found in reptiles and amphibians, has a weak musculature and the testes in two lateral fields. Apart from the relationship of the hosts, the other characters can exhibit intergrading stages of development when it would be impossible to make a generic determination. The separation of *Ophiotaenia* as a genus parasitic in reptiles and to a less extent in amphibians is very convenient and useful though much can be said against the retention of the group without the support of valid generic characters.

Beddard (1913) apparently unaware of La Rue's papers of 1911, erected a genus *Ophidotaenia* to include Proteocephalids, which he found in Indian and African snakes that had died in the Zoological Gardens of London. His genus is therefore synonymous with *Ophiotaenia* La Rue.

An allied genus *Tetracotylus* was erected by Monticelli in 1891 to include a cestode which he obtained from a *Silurus*, and which he called *Tetracotylus coryphicephala*. The same argument arose regarding *Tetracotylus* as occurred with *Proteocephalus*. La Rue (1911) pointed out that Filippi had used the name *Tetracotyle* in 1855 for a group of immature trematodes and La Rue coined the word *Monticellia* to replace *Tetracotylus*. This suppression of Monticelli's genus cannot be substantiated in the light of Article 36 of the Rules of Nomenclature already quoted. In 1930 Southwell combined the Monticellidae and the Proteocephalidae in the super-family Proteocephaloidea.

By 1924 the number of genera in the two families had increased to fourteen, and in the following year Woodland reviewed the family Proteocephalidae and proposed a drastic revision. He suppressed the family Monticellidae and united the existing genera into four genera:—*Proteocephalus*, *Marsypocephalus*, *Monticellia*, and *Rudolphiella*. In the same year Fuhrmann and Baer revised La Rue's family Monticellidae and they differ in their conclusions from Woodland, but as Fuhrmann and Baer did not discuss the family Proteocephalidae, the two conflicting views find no place for discussion here.

Woodland (1925) defines *Proteocephalus* as follows:—' *Proteocephalus* Weinland 1858. With all the reproductory organs situated either in the medullary region of the parenchyma (where this is distinguishable from the cortex) or in the undivided parenchyma (when the internal longitudinal muscle sheath is abseny). Vitellaria lateral, follicular, the follicles being closely grouped around a central conducting tubule. In fresh-water fishes, amphibians, and reptiles. Type species: *Proteocephalus filicollis* (Rudolphi) 1802 = *P. ambiguus* (Dujardin) 1845 '. This definition applies to ten then existing genera which are united in the one genus. Woodland's classification emphasized the fact that the Proteocephalid worms may be divided according to the relation of the genital organs to the cortex and medulla. In *Proteocephalus* all the genital organs lie in the medulla or undivided parenchyma. Apparently recognizing, however, that his genus *Proteocephalus* was too large and contained worms which in respect of characters other than the relative arrangement of the genitalia, Woodland divided it into two main groups or sub-genera. The sub-genera are those found in fresh-water teleostean fishes, and those found in reptiles, amphibia, and to a less extent in siluroid fishes. In the former sub-genus, which he called *Teleostaenia*, there is a small scolex, complete absence of spines and hooks, testes in one continuous field, and the vagina opening anterior to the cirrus, and in the latter sub-genus, for which, on grounds of priority, the name *Crepidobothrium* is retained, the scolex

is large or small, rostellum is present or absent, apical organ is present or absent, spines usually absent, testes usually in two lateral fields and the vagina and cirrus apertures irregularly alternating as to which is anterior. Woodland has maintained his classification with certain modifications, and up to 1934 has defined eight sub-families in the Proteocephalidae, some of these sub-families replacing the genera of his first classification. Each sub-family is characterized by the arrangement of the genital organs in relation to the inner muscular layer.

Southwell (1930) accepts Woodland's classification, but suggests that any stable character should be used for dividing the genus. He considers the arrangement of the testes in a single field useful only in extreme cases, and but a character of specific value. He agrees with Meggitt with regard to the possibility of using the arrangement of the genital ducts with reference to the longitudinal excretory canals as a character of possible generic value, but this character becomes valueless in those cases where, on account of their diffuse and branching nature, the excretory canals cannot be identified. Southwell discusses the value of a character of the scolex which in some cases can be used alone as a character to separate a genus. Magath does not think it wise to accept Woodland's sweeping revision, while Harwood (1933) proposes a new classification reviving some of the genera suppressed by Woodland.

The basis of Woodland's classification rests on the varying relationships of two parts, viz., the genital system; and the inner muscular layer which separates the parenchyma into cortex and medulla, on the assumption that the inner muscular layer is the more stable structure, and that the genital system is variable in relation to it. This classification ignores peculiar characters of the scolex, such as the presence of cuticular spines in *Acanthotaenia*, the presence of a fold behind the suckers in *Corallobothrium*, the presence of a posterior re-entrant notch in the suckers of *Crepidobothrium*, and the character of the arrangement of the testes in one or two fields. A character which separates *Proteocephalus* (Weinland) La Rue, from *Ophiotaenia* La Rue is host relationship; the former parasitic in catfishes, and the latter in reptiles and amphibians. From a phylogenetic standpoint it might be argued that those two groups arose independently, or from a single branch of the modified tetraphyllidean stock, but that each group evolved in relation to its own host. It is possible that worms of the parasitic stock of siluroids might become parasitic secondarily in aquatic reptiles, or vice versa, when convergence would result in the formation of intermediate forms. This may have occurred, and if so

would account for those few forms which have characters intermediate between those of the typical siluroid *Proteocephalid* and the typical reptilian *Proteocephalid*.

It would appear that the retention of such a large genus as *Proteocephalus* (Weinland) Woodland, even when divided into two subgenera, has little to recommend it on practical grounds, although from a theoretical standpoint there is much in its favour. I would retain the name *Ophiotaenia* for the cestodes described in this paper, either as a genus, as defined by La Rue, or better, to indicate more clearly the closer relationship of the group to the siluroid parasites than to the other genera of the *Proteocephalidae*, as a sub-genus of *Proteocephalus*. Such a sub-genus would have the characters assigned to it by Harwood. I would adduce in support of this conclusion, an argument similar to that used by Baylis in support of the retention of the genus *Acanthotaenia*. *Proteocephalus* (*Ophiotaenia*) is a group of parasites, mainly parasitic in reptiles, which possess the character of the testes divided into two lateral fields, with the negative character of absence of peculiarities of the scolex as seen in *Acanthotaenia*, *Crepidobothrium*, *Corallobothrium* and *Goezeella*.

In conclusion I accept the generic name *Proteocephalus* and regard *Ichthyotaenia* as a synonym, and accept the sub-generic name *Ophiotaenia* (La Rue) Harwood, with *Ophidotaenia*, Beddard, and *Solenotaenia* Beddard as synonyms, in preference to *Crepidobothrium* (Monticelli) Woodland.

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## Two Catadromous Fishes new to Ceylon

BY

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(With One Plate and One Text Figure)

The present paper deals with a catadromous eel and gobiid. Neither has been previously recorded west of the Malayan subregion. The discontinuous distribution of some purely fresh water fishes of Ceylon, e.g., the anabantid genus *Belontia* Myers<sup>1</sup> and the nematognathid species *Clarias teysmanni* Bleeker, which are otherwise confined to the Malayan subregion, and also the discovery by Schmidt that the Anguillidae of Ceylon migrate eastward to the sea off Sumatra to spawn, attaches considerable significance to the distribution of the two fishes now recorded.

### Genus *Gymnothorax* Bloch

*Asiatic Fishes* IX, 1795, p. 83

Apodal fishes with eyes covered with skin. Anterior nostrils tubate, posterior ones opening on top of head anterior to eye as round or ovate apertures. Gape extends behind eye. No paired fins, single ones confluent. Some teeth elongate, smooth; fangs depressible. Depth of body less than 30 in length.

### *Gymnothorax polyuranodon* (Bleeker) Pl. IV

*Muraena polyuranodon* Bleeker, 1853. *Nat. Tijdschr. Ned. Ind.* V, p. 248

*Gymnothorax polyuranodon* Bleeker, 1864. *Atlas Ichthyol.* IV, p. 89

This species is known, in Ceylon, from a single specimen taken in the Kaluganga.

Head length contained 5.15 in distance from snout tip to cloaca and 4.5 in tail length. Eye 20.8 and located above mid-gape, gape 4 in

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<sup>1</sup> The name *Belontia* was suggested by Myers to replace *Polyacanthus* Cuv. et Val.

4—J. N. 61668 (12/36)

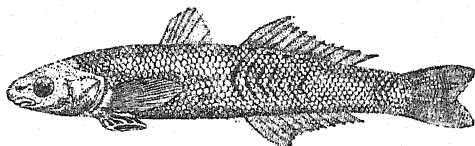


head and closes completely, depth 16.6. Gill openings oblique and larger than eye. Teeth conical, biserial upon jaws, the six mesial fangs smooth, moveable and uniserial. Body moderately compressed, the fins low and inconspicuous, tail spatulate. Colour white with irregular black blotches which are closer together and more frequently confluent dorsally than ventrally. Upon the head they coalesce to form about six longitudinal bands on each side. A white neural band, interrupted by black, is present.

*Dimensions* (in mm.). Total length 782; gape 18; eye 3.5; gill slit 8; snout tip to front of gill cleft 73; snout tip to back end of gill cleft 78; depth at mid body 47; depth above cloaca 46, head and body 410, tail 372.

*Distribution.* The specimen was taken with hook and line on February 5, 1936, from a deep pool of the Kaluganga known as Bogaha-vala close to the village of Kahangama and said to be about 30 metres deep. It is located beyond tidal influence and is about 57 kilometres above the river mouth and about 27 kilometres below its source.

Rivers of Ceylon, Sumatra, Java, Borneo, Palawan, Celebes, Buru, Ambon, Ceram, Waigeu, North New Guinea, Fiji Islands.



P. Deraniyagala del.

Fig. 1. *Sicyopterus gymnauchen*  $\times 2$

### Genus *Sicyopterus* Gill

*Proc. Ac. Nat. Sci. Philadelphia* 1860 (*Sicydium stimpsoni*)

Body subcylindrical. Head naked with well developed sense pits. Tongue free. Branchiostegals 5. Gill membranes fused to isthmus under pectoral. Eye sub-cutaneous, nostrils apart. Lips fleshy, with ciliate teeth in lower one. Postlabial groove interrupted in middle. Two anterior canines on lower jaw. No teeth on vomer, palate or tongue. Scales 50-80 mostly ctenoid, cycloid on nape and along base of dorsal; indistinct on nape and near ventral fin. Ventrals united completely, cupshaped and partially adnate  $1.5 + 5.1$ . Distance between last two spines of first dorsal is thrice distance between any other pair of spines. Caudal fin rounded or emarginate.

**Sicyopterus gymnauchen** (Bleeker)

*Sicydium gymnauchen* Bleeker, 1860. *Act. Soc. Sci. Indo-Nederl.* VIII

*Microsicydium gymnauchen* Bleeker, 1874. *Arch. Nederl. Sci. Nat.* IX

*Sicyopterus gymnauchen* Koumans, 1929. *Bleek. Zool. Med. Leiden.* XII

*Kongani*, *Heen kongani* (young) *Kos kongani*, *Pol kongani* (adolescent or adult)(s) Sinh.

This form was previously known only from a few places in the Dutch East Indies (Celebes, Ambon Seri). Bleeker (1874) placed it in a new genus *Microsicydium*, of which it was the type, but Koumans (1929) united it with the genus *Sicyopterus* Gill 1860.

*Fins.* I D. VI, II D. 1.10, A 1.10, P 20, V  $1.5 \times 5.1$  C 13. Ventrals completely united, partially adnate and cup shaped.

*Scales.* Markedly ctenoid, least prominent on nape and near ventral fin. Cycloid on nape and along base of first dorsal. Absent on head, chest and between ventral and pectoral fin. L. L. 54-56. Ltr. 15. predorsals 13. preanals 18.

*Measurements.* Head 4-4.5, eye 4-4.5, interorbit 0.9, snout 1-1.2, depth of body 5.2-5.8, pectoral 5-5.7, ventral 7-8.3. Caudal 4.8 into length.

*Description.* (Adult). Snout bluntly acuminate, nostrils set apart. Mouth terminal in young, subinferior in adult. Gape faintly oblique, nearly reaches eye which is subcutaneous. Lips thick, the upper completely exposed in young, partially covered by a rostral flap in adult. Postlabial groove interrupted in middle of lower jaw. Gill membranes fused to isthmus near root of ventral fin. Head with sense pits and mucus pores well developed. Two vertical rows of pits cross each opercle and are continued over vertex to opposite side. Each row is 'V' shaped at vertex and points anteriorly. A row of sense pits under eye and round nostrils. Tongue free, truncate. Teeth villiform on upper jaw with outer row enlarged. Lower jaw with two anterior canines. Lower lip with a row of ciliate dermal teeth. Body subcylindrical, caudal peduncle longer than deep. Ventrals confluent, cup shaped, with a well defined rim; partially adnate with belly and inserted under pectorals, which are elliptical with a serrate margin and reach to under fourth dorsal spine. Single fins lower than body depth and higher anteriorly than posteriorly. Last spine of first dorsal is the shortest and is thrice as far from the next spine as the rest are to each other; the median spines longest. Unbranched ray in second dorsal and anal shorter than branched rays. Origin of anal under that of second dorsal. Their margins gently emarginate and dentate. Second dorsal about 1.5 orbits behind first and separated by six scales. Caudal emarginate. Length of fish 30 mm.

(Young). 14 to 17 mm. long; the upper lip is thick and not overlapped by the rostral flap while the ventral fin extends as far back as the pectoral and is spatulate. Scales are fully developed, the ventral fin short and circular, and the upper lip partially covered by the rostral flap in specimens 20 mm. long. The largest specimens obtained were 28 to 30 mm. long and were probably adolescents.

*Colours*<sup>1</sup>. Translucent with green on vertex, yellow and green on opercle. Four or five red chromatophores on each side of base of second dorsal, below which are seven or eight 'V' shaped dark lateral bands and three similar ones at end of tail. There are five or six melanophores along base of anal but in young specimens these are continued anteriorly on either side of belly.

*Reproduction and habits*. Catadromous. A bottom dwelling shallow water form usually entering fresh water in May, occasionally in January, when numbers of this Ceylon's most delicately flavoured fish are caught at the river mouths<sup>2</sup>. Collected by me at the mouth of the Kaluganga on 24.5.26, 6.5.27, 10.5.29, and 30.5.32, also from the Panadura river mouth 6.5.27. Young and adolescents or adults are taken together. In January, 1934, shoals of heen kongani were taken six kilometres up the Kaluganga.

Swarms of the estuarine sand eel *Sphagebranchus polyophthalmus* (Bleeker) appear in the sand of the river mouths during the kongani season and prey on this fish. When the migration ceases the eels disappear. The kongani<sup>3</sup> is very positively rheotropic and catches are largest when the river is in flood just after heavy rain. If water is poured down the side of a basin containing these fishes they make violent attempts to ascend the stream, up the side of the basin. When no water is poured in the fishes assemble in circular formation heads directed against the current as it swirls round within the basin.

*Distribution*. Ceylon [Colombo, Panadura, Kalutara (W.P.)]. Celebes, Ambon Seri.

#### EXPLANATION OF PLATE

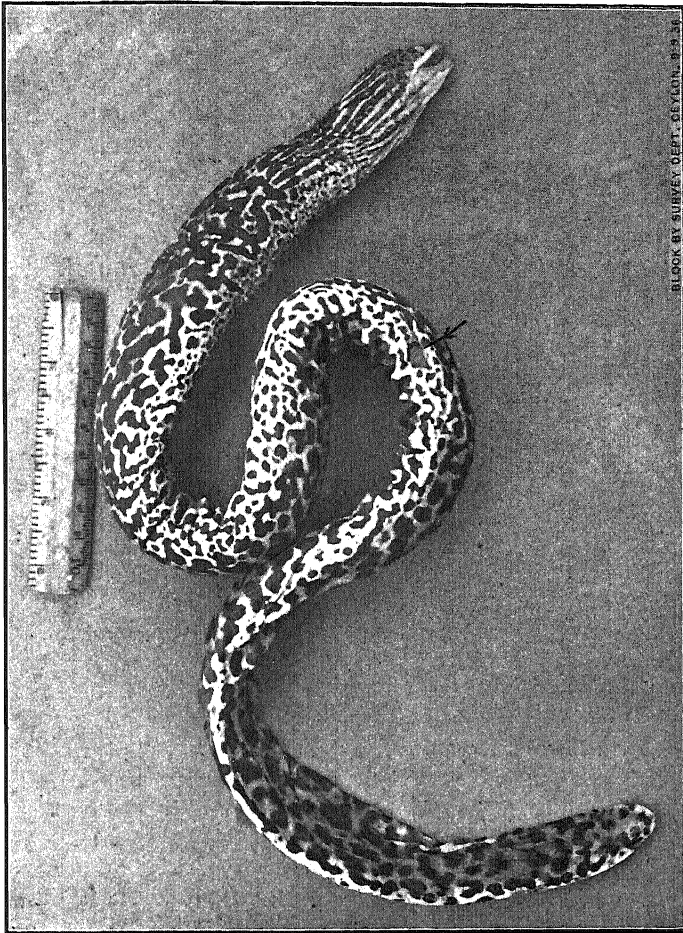
PLATE IV. Photograph of *Gymnothorax polyuranodon* Bleeker

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<sup>1</sup> The colours differ from the types of Bleeker.

<sup>2</sup> Taken in the Saluva dhala, a net of mosquito gauze 2 x 5 feet, dragged along the sand by two men. About six such nets are in use at Kalutara during May.

<sup>3</sup> Among the fishing caste of Ceylon, especially in the Colombo District, this name is frequently employed as a clan name. The names of other fishes do not appear to be employed for such a purpose.



*Gymnothorax polyuranodon* Bleeker



## A New Gecko *Hemidactylus maculatus hunae*

BY

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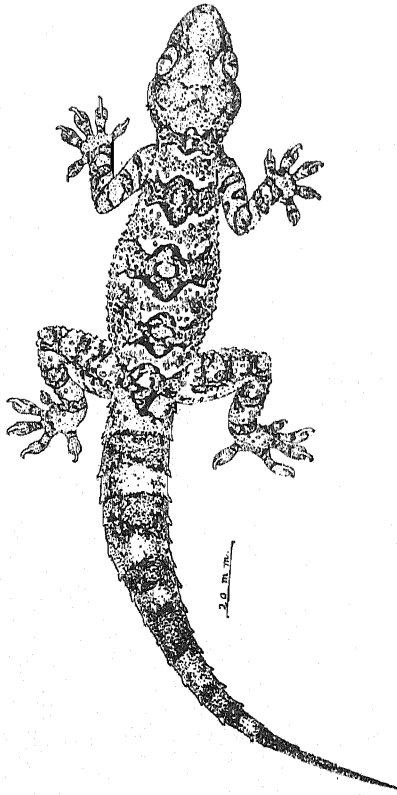
(With One Text Figure)

The type locality of *Hemidactylus maculatus* Dum. et. Bibr. is Bombay. Günther later described a Deccan specimen as *Hemidactylus sykesi*. According to Smith<sup>1</sup> the gecko is only known from the Bombay District, Malabar, Tinnevely, and Salem, near Madras, and evidently Gunther's record<sup>2</sup> of this species as occurring in Ceylon is not authentic. The first specimen known from Ceylon was obtained recently from the south-east of the Island. As it did not agree with the existing descriptions for *H. maculatus* and was thought to be a distinct, but allied to this species, it was submitted to Mr. H. W. Parker of the British Museum for comparison with specimens in his charge. Mr. Parker agrees with me that the specimen is distinct from the typical form and that the South Indian and Ceylon forms should be separated from the northern form with which it has hitherto been identified. He very kindly lent me two specimens of the northern form and eleven specimens from South India for examination, and states that in the former the mental is usually very much wider than long, while the posterolateral scales are progressively enlarged and tubercular, forming a clear line of demarcation between the laterals and ventrals, immediately anterior to the hind limbs; whereas in the latter the mental is usually as long as wide and the posterolateral scales grade imperceptibly into the laterals. Examination of the series suggests that there are two subspecies. The northern subspecies is the *forma typica*, while the southern form, which includes the Ceylon gecko, will be designated by the racial name of *hunae*, the Sinhalese equivalent for 'gecko' being 'huna'.

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<sup>1</sup> Smith 1935. *Faun. Brit. Ind., Reptilia*, Vol. II.

<sup>2</sup> Gunther 1854. *Rept. Brit. Ind.* p. 108.



P. Deraniyagala del.

Fig. 1. *Hemidactylus maculatus hunae*, sub-sp. nov.  $\times 1$

***Hemidactylus maculatus hunae*, sub-sp. nov.**

Snout obtuse; as long as or longer than distance from eye to ear. Supralabials ten to twelve, infralabials nine to ten. Mental subtriangular, wider than the rostral and usually as long as wide. Postmentals two pairs, the inner enlarged. Gular scales fine, granular. Rostral subquadrangular, broader than high; nostril between rostral, first labial and several small scales; a pair of internasals. Snout with convex scales, occiput with granular scales and larger conical tubercles. Back with small scales and about fifteen to twenty longitudinal rows of tubercles, which are smallest along the mid dorsal line and are feebly

trihedral. Ventrals smooth, imbricate, rounded scales which grade imperceptibly into the laterals postero-laterally, immediately anterior to the hind limbs. Digits free, moderately dilated with almost straight transverse lamellae, nine or ten under the inner toe, eleven to thirteen under the fourth toe. Tail feebly depressed, with about sixty wide subcaudals and dorsally with six or four longitudinal series of tubercles which are usually low and subconical, rarely trihedral. Males with nineteen to twenty-five femoral pores on each side, separated from those of opposite side by two to sixteen scales.

*Colours.* Dorsally silvery-grey with five broad transverse olive, brown bands from neck to hips. Each band possesses a black margin and forms a rhomboid vertebral enlargement with a light centre containing a black ring. Tail with about six dark rings a little wider than interspaces. Limbs with five or six irregular rings on each. Two lateral bands on each side of head. Ventrally white, dusted with brown, especially on tail. Young with the dorsal cross bands without any light areas.

*Type specimen:* A female from Okanda, Eastern Province, Ceylon. Taken in a rock cave. Snout to ear 28 mm., snout to cloaca 105 mm., tail 115 mm. It has been deposited in the British Museum.

*Range.* Ceylon and South India comprising Malabar, Tinnevely, and Salem, near Madras.

#### *Material examined*

The following specimens numbered according to the British Museum Register were examined:—

No. 69. 8. 28. 16. from Matharan (*forma typica*). A male with twenty femoral pores separated by eight scales from eighteen pores. Tubercles developed on arms, and small ones present along back edge of each thigh. Caudal tubercles large, trihedral and in eight longitudinal rows up to first half of length, posteriorly six rows.

No. 69. 8. 28. 17. from Matharan (*forma typica*). No femoral pores, tubercles resemble those of previous specimen. Dorsal pigment bands broken up into four longitudinal rows of large spots.

No. 74. 4. 29. 1411. from Malabar (young). Dorsal tubercles relatively larger than in adult and in eight to six longitudinal rows on tail.

No. 74. 4. 29. 1183. from Salem. Tubercles subconical, small, in neural rows, vestigial on arms, none on posterior borders of thighs, in four longitudinal rows on tail.



No. 74. 4. 28. 1184. from Salem. Tubercles small, in neural rows, vestigial on arms, none on posterior borders of thighs.

No. 74. 4. 28. 1185. from Salem. Femoral pores twenty-four on one side; twenty-five on the other separated by two scales. Tubercles as in previous specimen.

No. 74. 4. 28. 1186. from Salem. Tubercles same as in previous specimen.

No. 74. 4. 28. 1187. from Salem. Tubercles as in previous specimen, low on tail and in four longitudinal rows.

No. 74. 4. 28. 1188. from Salem. Tubercles as in previous specimen.

No. 74. 4. 29. 1049. from Tinnevely. Tubercles present on arms and along posterior edges of thighs.

No. 74. 4. 29. 1050. from Tinnevely. Nineteen femoral pores separated from twenty by sixteen scales. Tubercles strong, trihedral, in eight to six series along tail, feeble upon arms.

No. 74. 4. 29. 1051. from Tinnevely. Twenty femoral pores on each side separated by twelve scales. Tubercles feeble upon arms, developed along back of thighs, neural series feeble, caudal ones trihedral.

No. 83. 9. 5. 1. from Malabar. Twenty-three femoral pores separated from twenty-five by three scales. Tubercles vestigial upon arms, absent from back of thighs, neurals small, caudals in four longitudinal rows and subconical.

#### SUMMARY

In conclusion the salient differences between the northern form, viz., *H. m. maculatus* and the southern form *H. m. hunae*, between which there appears to be some degree of intergradation are as follows:—

(1) *H. m. maculatus* (northern sub-species). Mental usually very much wider than long, pentagonal. Dorsal tubercles subequal, strong, acutely trihedral and present upon arms and thighs including posterior margins of latter. Caudal tubercles acute and in eight to six longitudinal rows. Posterolateral ventral scales progressively enlarged and tubercular, forming a distinct *line of demarcation* between ventrals and laterals immediately anterior to hind limbs. The dark borders of the dorsal brown bands are comparatively straight and tend to break into spots in adult. The animal is larger and stouter than the southern form.

*Range.* Bombay Presidency, Deccan.

(2) *H. m. hunae* (southern sub-species). Mental usually as long as wide, triangular. Dorsal tubercles usually weaker than in the northern form and frequently only feebly trihedral, or even sub-conical, the neural series small, usually vestigial or absent from arms and from back edge of each thigh. Caudal tubercles usually moderate, or low and sub-conical, and in six to four longitudinal rows. Posterolateral ventral scales *grade imperceptibly into* the laterals immediately anterior to hind limbs. Each dark, dorsal band usually expanded into a rhomboid mark, with a lighter centre at middle of back.

*Range.* Ceylon and South India.



## Some Miocene and Upper Siwalik Vertebrates from Ceylon

BY

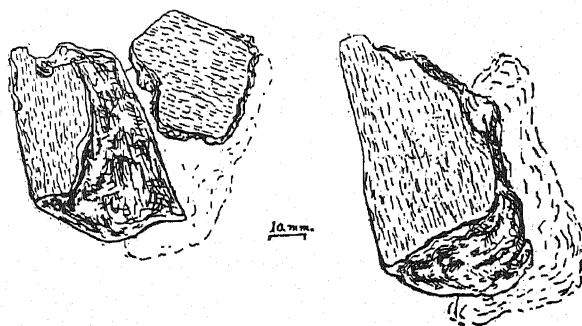
P. E. P. DERANIYAGALA, M.A. (Cantab.), A.M. (Harvard),  
F.L.S., F.Z.S.

*Assistant Marine Biologist, Department of Fisheries*

(With Two Plates and Four Text Figures)

The present paper is a brief account of some vertebrate fossils from Ceylon, namely, (A) bone fragments discovered in Miocene sandstone of marine origin, and (B) teeth from deposits of Upper Siwalik age, from the inland Province of Sabaragamuva 51 kilometres (32 miles) from the sea.

(A) *Miocene fossils*. These were discovered in sandstone, which casts of such marine bivalves as *Tellina*, *Chlamys*, *Ostrea* and *Placuna*, as well as the detached teeth of nine genera of marine fishes comprising *Selachii* and *Pisces*<sup>1</sup>, proved to be of marine deposition. These rocks



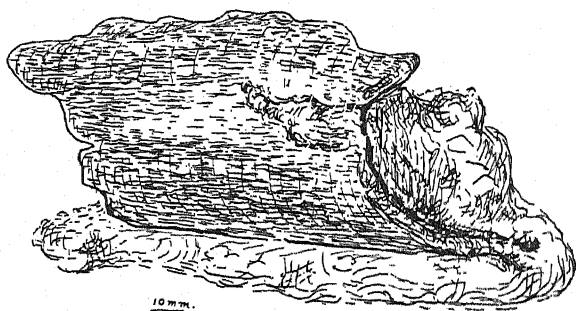
P. Deraniyagala del.

Fig. 1. ?Marginals with matrix attached

<sup>1</sup> These fish fossils will be described in a subsequent issue of this journal.

were exposed between tide levels at Arua kallu, also known as Muringé Malé, on the east shore of Dutch Bay in the North-Western Province of Ceylon. The bones which occupied an area of about six square metres were more or less completely mineralized, and so firmly embedded in sandstone that a hammer and chisel were necessary to extract specimens. The majority were flat, while a few were cylindrical and were, apparently, parts of limb bones of considerable size. A conspicuous feature was the absence of vertebrae, and no parts could be recognized as belonging to the skull.

Under the circumstances, it seemed at first impossible to arrive at any conclusion as to the animal's identity, but further consideration suggested that the flat pieces of bone belonged to the carapace of a large marine thecophoran turtle. Supporting this view are pieces of what appear to be two marginal bones (fig. 1). The absence of vertebrae also supports the view that the animal was a thecophoran, for in such turtles the dorsal vertebrae are more or less reduced and adherent to the carapace, and if the dead animal lay prone it is likely that they would be embedded in sandstone.



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Fig. 2. Fragment of a long bone, with matrix attached  $\times \frac{2}{3}$

There were two fragments of long bones. Each was 125 mm. long and the thickness of bone was 12 mm. The diameter of the better preserved piece was about 40 mm. (fig. 2). The thickness of the various pieces of bony plates was from 13 to 14 mm. The specimens will be deposited in the Colombo Museum.

(B) *Upper Siwalik fossils.* The stratigraphy of the fossil deposits of Upper Siwalik age in Ceylon has been discussed elsewhere and the

name 'Ratnapura' proposed for their horizon (Deraniyagala 1936, p. 316). Consequently this aspect will not be dealt with in the present paper, which is essentially a description of the teeth of extinct members of the Elephantidae, Rhinocerotidae and Hippopotamidae from Ceylon.

It is known that each of the above family contains a number of extinct genera and species, the latter usually within close proximity to one another, while their living representatives display an equally, if not greater, restriction in specific and subspecific range of distribution, *e.g.*, the elephants form two genera, *Loxodonta* of Africa existing as fifteen subspecies, and *Elephas* of south-eastern Asia forming three. One of these latter is confined to Ceylon. The Rhinoceroses form two living genera in Africa and two more in Asia, while the Hippopotamus survives in Africa as two species and several subspecies.

Fossils of Siwalik age are known from the Siwalik area in India, the Irrawady delta in Burma and from Java and Africa. As there are nearly fifteen degrees of latitude separating Ceylon from the nearest Siwalik area, viz., the Indian one which has the Narbadda river as its southern boundary, it is probable that the Ceylon animals now tentatively placed with their nearest Indian relatives, will, when better known, prove to be either distinct species or subspecies. The specimens here described, which will be deposited in the British Museum, were obtained from two localities in the Province of Sabaragamuva, viz., an estate belonging to Mrs. A. H. E. Molamure at Kuruvita and from Potgul kanda.

## Order PROBOSCIDEA

### **Palaeoloxodon** Matsumoto

*Palaeoloxodon* Matsumoto, 1924. J. Geol. Soc. Tokyo, XXXI, N 371, p. 257

Extinct elephants with a strong transverse frontal ridge and with hypsodont teeth, from the upper Pliocene and Pleistocene of Asia, Southern Europe and Northern Africa.

### **Palaeoloxodon namadicus** (Falconer et Cautley) (Plates V, VI)

*Elephas namadicus* Falconer et Cautley, 1846. *Fauna Antiqua Sivalensis*, pt. 2, pl. XIII

The probability that some of the fossil proboscidean molars discovered in Ceylon by the author might belong to *Palaeoloxodon namadicus* (Falconer et Cautley), was suggested by Dr. A. Tindell Hopwood of the

British Museum (Deraniyagala 1936). Subsequent acquisition of a number of more or less complete molars shows that this view is correct. Further investigation might reveal that two species of *Palaeoloxodon* lived in Ceylon, a large one which is probably a subspecies of *P. namadicus* (Falconer et Cautley) and a smaller species possibly from another level.

The specimen figured in Plate VI, figs. 1, 2 is an upper front molar which has lost its last two or three enamel folds. Seven folds are intact and probably the entire tooth originally possessed nine or ten in all. Each rises above the cement to a considerable height, (Pl. VI, fig. 2) and is feebly expanded at the mid longitudinal axis of the crown, the enamel is crenulate upon both surfaces (Pl. VI, fig. 1).

This specimen is from the Kuruvita estate and was reported to have been obtained about eight metres below the surface. Its dimensions are as follows:—length of crown 112 mm.; width of crown 65 mm.; diagonal length from crown tip to root 140 mm.; projection of third and fourth enamel folds above cement 11 mm.

#### ***Palaeoloxodon* sp. (Plate V, fig. 2)**

In 1934 part of an elephant molar from Potgulkanda was sent to Dr. A. Tindell Hopwood, for his opinion. His comment was "extinct but species not determinable". The subsequent acquisition of four more or less similar specimens from the same, as well as other, localities suggests that these teeth belonged to a smaller species than the preceding one. The enamel folds do not rise above the cement of the crown, are more coarsely crenulate, especially on the external aspect, and are closer together than in the larger form; viewed anteriorly, the outline of each enamel fold is subovate. The specimens were obtained from depths of ten to twelve metres.

The dimensions of three from Potgulkanda were as follows: greatest length 80 mm.; width 65 mm.; depth 120 mm.; width of crown 66 mm.; thickness of each enamel fold 11 mm.; thickness of each interspace 5 mm.

The tooth comprised five enamel folds and a talon. The last fold was entire whereas the others had come into use. Each enamel fold displayed only four cusps which were most worn towards the middle of the tooth. The enamel of each fold was crenulate on both surfaces and cement filled the interspaces completely.

The other specimens consisted of two pieces, each comprising three enamel folds which had not yet come into use. The depth was 110 mm., the width 50 mm. Both probably belonged to the same animal.

A specimen from Kuruvita (Pl. VI, figs. 1-2) comprising three unworn enamel folds was 115 mm. deep, 63 mm. wide. The lateral thickness of an enamel fold was 11 mm. These folds were somewhat thicker than the cement interspaces.

A specimen from Karmarangapitiya also comprised three unworn enamel folds and a talon. The specimen was 115 mm. deep, 61 mm. wide and the lateral thickness of each enamel fold was 10 or 11 mm. The enamel folds displayed remarkably well the coarse crenulation previously mentioned.

### Order PERISSODACTYLA

#### **Rhinoceros** Linné (Plate VI, figs. 3-4)

*Rhinoceros* Linné, 1758. Syst. Natural X

Rhinoceroses with a single nasal horn, cutting teeth in both jaws, manus with three digits. Pliocene to recent, restricted to Asia.

In Asia the family Rhinocerotidae comprises a number of extinct as well as living genera. Some of these vary in the number of digits, and nasal horns, while one lacks the latter. The family is known in Ceylon from two lower molars found within a period of three months of each other, and close to molars of a species of hippopotamus. This association suggests that the rhinoceros might possibly have belonged to the short limbed teleocerine group which are thought to have frequented the neighbourhood of slow flowing rivers. However for the present the Ceylon animal is tentatively assigned to *Rhinoceros sivalensis* Falconer et Cautley.

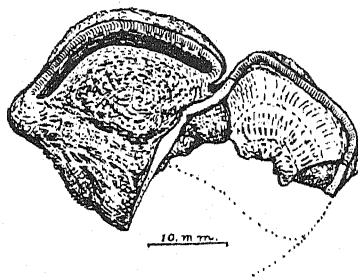
#### **Rhinoceros sivalensis** Falconer et Cautley

*Rhinoceros sivalensis* Falconer et Cautley, 1847. Fauna Antiqua Sivalensis

The teeth are two lower molars of the usual lophodont type. The one here described (Plate VI, fig. 3) is a last lower left molar fractured on the lingual surface of the anterior pillar. The posterior pillar is more or less intact and its crown shows a narrow, crescentic metaloph close to its labial margin which is a ridge marked with fine crenulations resembling the 'milling' upon the rim of a coin (Plate VI, fig. 4). The dimensions of the tooth are as follows: length across crown 44 mm.;



length across crown of anterior pillar 20 mm.; height of anterior pillar 41 mm.; length across crown of posterior pillar 30 mm.; height of posterior pillar 36 mm., length of metaloph 26 mm.



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Fig. 3. Crown of molar of *Rhinoceros ?sivalensis*  $\times \frac{1}{2}$

## Order ARTIODACTYLA

### **Hexaprotodon** Falconer et Cautley

*Hippopotamus (Hexaprotodon) sivalensis* Falconer et Cautley, 1836. Asiatic Researches XIX

Extinct hippopotami with six incisors in each jaw; from the Pliocene and Pleistocene of Asia and Africa.

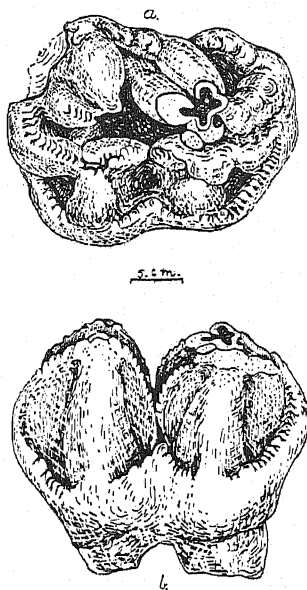
This generic name was originally applied by the authors in a sub-generic sense to the hippopotami of the Upper Siwalik beds. Modern investigation has shown that the name is entitled to generic rank. This genus is considered more primitive than *Hippopotamus*. The Asiatic representatives of the family Hippopotamidae are extinct and all appear referable to *Hexaprotodon*. The Ceylon form, known from four molars and part of an incisor obtained on different occasions, from the same locality, is tentatively assigned to *Hexaprotodon sivalensis* Falconer et Cautley.

### **Hexaprotodon sivalensis** Falconer et Cautley (Plate V, fig. 3)

*Hippopotamus (Hexaprotodon) sivalensis* Falconer et Cautley, 1836. Asiatic Researches XIX

The description and figure of the first molar discovered, which is now in the British Museum, appears elsewhere (Deraniyagala 1936). Other teeth were discovered subsequently on the same estate at a depth of about ten metres. The specimen now described is a lower left molar found as four fragments, and when these were assembled, one cusp was still missing and only one was in wear.

A noticeable feature of the teeth was the strong convolution of the cusps which differ in this respect from those figured by Falconer and Cautley in *Fauna Antiqua Sivalensis*. The dimensions of this tooth are as follows: crown length 57 mm.; crown width 44 mm.; depth 49 mm.



P. Deraniyagala del.

Fig. 4. Molar of ?*Hexaprotodon sivalensis*  $\times \frac{1}{10}$

(a) Crown, (b) Lateral view.

#### SUMMARY

The genera of extinct vertebrates described in this paper are as follows:—

#### *Miocene*

? Class Reptilia

? Order Testudinata

#### *Lower Pleistocene*

*Ratnapura horizon* (Upper Siwalik age)

Class Mammalia

Order Proboscidea

Family Elephantidae

Genus *Palaeolorodon* Matsumoto

Order Perissodactyla

Family Rhinocerotidae

Genus *Rhinoceros* Linné

Order Artiodactyla

Family Hippopotamidae

Genus *Hexaprotodon* Falconer et Cautley.

The extinct vertebrates of Ceylon thus briefly described comprise a Miocene form which is probably a marine thecophoran turtle, at least one elephant as well as a rhinoceros and hippopotamus, of upper Siwalik age. The hippopotamus remains suggest that during upper Siwalik times there were numerous large, slow-flowing rivers with broad flood plains among the hills of Sabaragamuva. Sometime these rivers appear to have entered lakes, which they eventually silted completely before they themselves ceased to exist. Such deposits yield a considerable proportion of the more valuable gems, which were probably in large measure exposed as a result of subaerial decomposition of the matrix, and the rivers deposited these gems either immediately prior to or simultaneously with the bones of the animals mentioned. Fossiliferous beds, however, are sufficiently uncommon in Ceylon, for Wayland, a former Government Mineralogist to state (1916), that although the Mineralogical Department had been on the look-out for vertebrate fossils since its inception in 1903, none had been discovered, and it was consequently thought that the climatic conditions of Ceylon were not conducive to the preservation of bones.

#### REFERENCES TO LITERATURE

- DERANIYAGALA, P. E. P. 1936. Some Vertebrate fossils from Ceylon. *Geological Mag.*, LXXIII, pp. 316-318, figs. 3  
 WAYLAND, E. J. 1916. *Equus zeylanicus*. *Spolia Zeylanica*, Vol. X, pp. 274-275

#### EXPLANATION OF PLATES

##### PLATE V.

Fig. 1. Separated enamel folds of a molar of *Palaeoloxodon namadicus* from Potgul kanda

Fig. 2. Molar of *Palaeoloxodon* ?from Potgull kanda

Fig. 3. Molar of *Hexaprotodon sivalensis* from Kuruvita specimen in British Museum

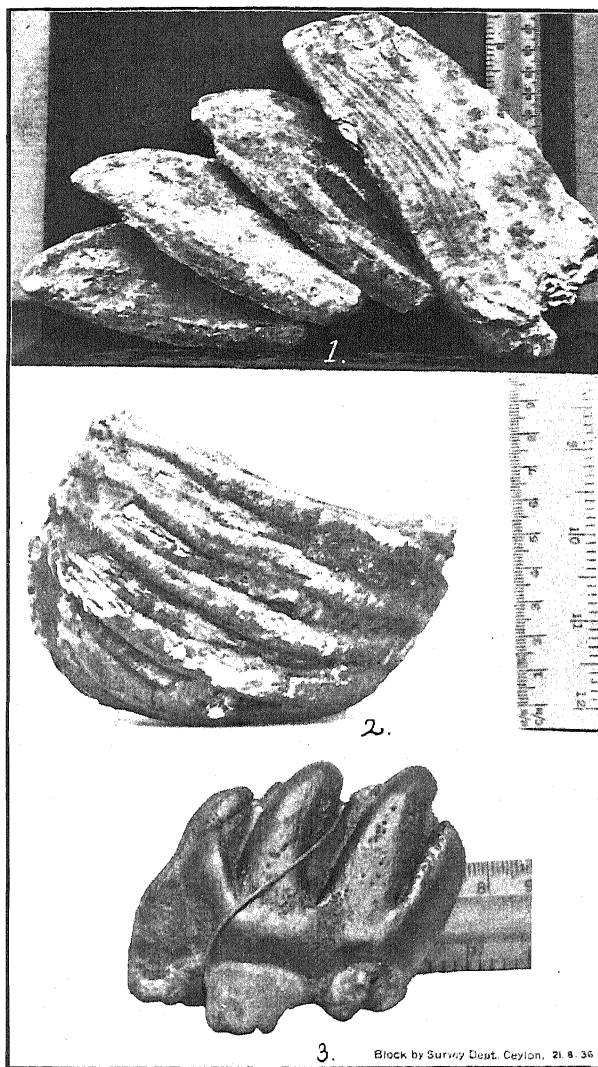
##### PLATE VI.

Fig. 1. Crown of upper front molar of *Palaeoloxodon namadicus* from Kuruvita

Fig. 2. Side view of molar of *Palaeoloxodon namadicus* Kuruvita

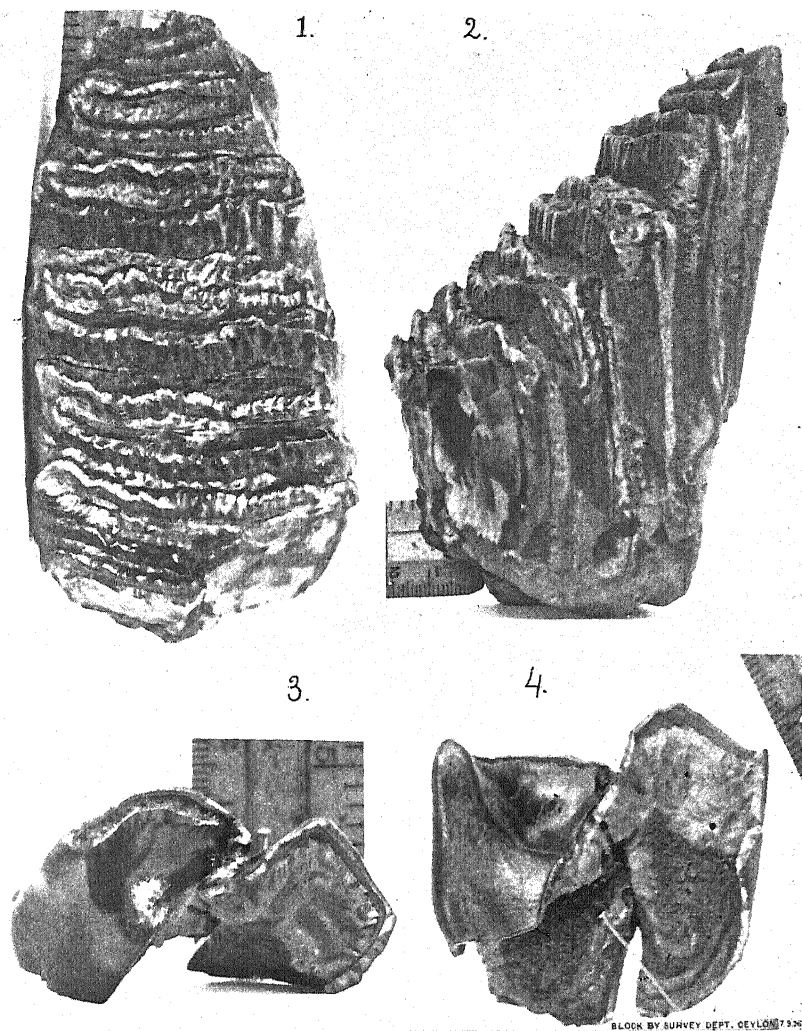
Fig. 3. Crown of last lower left molar of *Rhinoceros sivalensis* from Kuruvita

Fig. 4. Lingual surface of molar of *Rhinoceros sivalensis* from Kuruvita



*Vertebrate Fossils from Ceylon*





*Vertebrate Fossils from Ceylon*



## Survey of the Distribution of Mammals of Ceylon

BY

W. W. A. PHILLIPS, F.Z.S., F.L.S., M.B.O.U.

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### REPORT No. 14

Collection	...	...	No. 18
Locality	...	...	Nikkawewa, in the Veddichchai Game Reserve, North-Central Province.
Altitude	...	...	Approximately 200 feet.
Date	...	...	January 19/26, 1936.
Collector	...	...	W. W. A. Phillips and Collector William Perera.

The collection to which this report refers was made during a short hunting trip in the Resident Sportsman's Reserve. This Reserve is more commonly called the 'Veddichchai country' and the temporary camp is pitched at Nikkawewa towards the eastern boundary.

Nikkawewa lies some ten miles south-west of Kantalai Rest House on the Dambulla/Trincomalie main road. The camp site is on the bund of an ancient breached 'tank' or irrigation reservoir. There is no permanent habitation within five miles or more.

The surrounding country is wild and uninhabited in every direction and is composed of wide stretches of grassland, dotted with large trees and termite mounds, and intersected by belts of tall forest and scrub. A belt of tall forest, some six miles in width, divides this open country from the main road and the railway. Throughout the area there are scattered the remains of many ancient tanks, their bunds breached, but holding a certain quantity of water during the wet season. The country is, generally speaking, flat but slightly undulating and rarely rises above 200 feet above sea level. The forest is typical dry zone secondary jungle—that is to say, it is chiefly composed of medium sized trees with light undergrowth, intersected with tracts of scrub and thorn jungle and by belts of taller forest along the stream banks.

The annual rainfall averages approximately 67 inches, by far the greater part of which falls during the north-east monsoon period—



November to January. During the remainder of the year the country is dry and often parched, but subject to infrequent thunderstorms.

The general fauna of this area is closely related to that of the southern part of the Indian mainland, that lies adjacent to Ceylon.

The most interesting specimens, collected on the trip, are the two Indian Musk-shrews, trapped far from human habitations, the two Giant Squirrels, illustrating an interesting phase of colour-change and the four White-tailed Rats, that increase the known range of the species.

(No. 30) **Saccolaimus saccolaimus** (Temminck)

The Pouch-bearing Sheath-tailed Bat

1♀. Typical.

Two shot but only one preserved. On two occasions, several of these bats were driven out of hollow trees by Monitor-lizards that scrambled into the hollows in order to hide from our close approach. The species is common throughout the area. (*See also Reports Nos. 8 and 12*).

(No. 32B) **Suncus caeruleus caeruleus** (Kerr)

The Common Indian Musk Shrew

2♂♂. Typical.

It is interesting to find this species far out in the jungle, many miles from the nearest human habitation. Hitherto, almost all the specimens procured had been taken in, or adjacent to, towns or villages. The species would now appear to be well scattered throughout the dry zone, both in the jungles and in the populated areas. (*See also Report No. 10*).

(No. 58) **Canis lanka** Wroughton

The Ceylon Jackal

1♀. Shot but not preserved.

Common throughout the Reserve. On several occasions dog-like barking was heard close to the camping-ground, but the author of the sound could not be collected. The Game-Watchers declared that the barking was made by a very old jackal. (*See also Report No. 10*).

(No. 65A) **Ratufa macroura sinhala** Phillips

## The Common Ceylon Giant-Squirrel

1 ♀ adult; 1 ♂ Sub-adult.

Two very interesting specimens, demonstrating the colour change to which the race is subject. With the exception of several small patches of dark, new hairs dotted about both on the shoulders and the sides, the shoulders and dorsal area of the female are light yellowish buff, so light as to be only a few shades darker than the belly. The hairs in this region have faded completely and are about to be shed and replaced. The new hairs appear in patches and are dark blackish-brown, frosted with greyish-white. In the young male, the shoulders and dorsal area are plain light buff, without the yellowish tint; there are no patches of new hairs but on the rump area they are beginning to replace the old faded hairs.

Evidently in some individuals, the colour change is gradual, the old faded hairs being gradually replaced by the new, while in others the coat is renewed, more rapidly, in irregular patches. Both these specimens were shot in the same tree, on January 24. (*See also Reports Nos. 3, 5, 7, 11, and 12*).

(No. 66) **Funambulus palmarum**, sub-sp.

## The Ceylon Palm Squirrel

1 ♂. 1 ♀.

Both these specimens were taken in rat-traps set in the jungle. They are common throughout the whole area. In both, the median stripe is white and the two outer are buff. There is no sign whatsoever of any reddish cap. Until further work has been done on the Palm-squirrels of Ceylon, I am not prepared to assign these specimens to any definite race.

(No. 76) **Rattus rattus kandiyanus** (Kelaart)

## The Common Ceylon House Rat

3 ♂♂. 3 ♀♀.

All these specimens were trapped, together with a number of others that were not preserved, in the jungle surrounding the camping ground. All have the typical white belly, with no signs of any darkening at the base of the fur, and the upper parts have a distinct rusty-rufous tinge. (*See also Reports Nos. 2, 7, 10, 11, and 12*.)

(No. 78) **Rattus blanfordi** (Thomas)

## The White-tailed Rat

2♂♂. 2♀♀. Typical.

Four very useful specimens of this little-known rat were trapped in the scrub and grassland a few hundred yards from the camp. The bellies in these specimens are milk-white in contrast to the creamy-white of the bellies of *R. r. kandiyanus*. This species appears to live in the termite-hills scattered about the grass and scrub lands, rather than in the heavy jungle. (See also Reports Nos. 7, 11, and 12.)

(No. 79) **Millardia meltada meltada** (Gray)

## The Soft-furred Rat

1♂. Typical.

Only one Soft-furred Rat was trapped on this trip, although, on a former trip, several were taken in the swamp in front of the camp. The species is not common in this area but it appears to occur wherever suitable cover is present.

The following mammals were observed during the trip but not collected:—

(No. 1) **Macaca sinica sinica** (Linnaeus)

## The Ceylon Toque Monkey

Common, in troops, in the heavy forest and around the abandoned tanks. (See also Report No. 12.)

(No. 2) **Pithecus entellus thersites** (Blyth)

## The Ceylon Langur

Common, in troops, in the forest and around the abandoned tanks. (See also Report No. 12.)

(No. 20) **Pipistrellus coromandra** (Gray)

## The Coromandel Pipistrel

Very common, flying above the open jungles, in the evening. Lives in small holes in branches of trees. (See also Reports Nos. 2, 6, 9, 12, and 13.)

(No. 29) **Hesperoptenus tickelli** (Blyth)

## Tickell's Bat

Observed, once or twice in the evenings, flying over the abandoned tank at Nikkawewa. A common species in the dry zone. (*See also Reports Nos. 2, 3, 5, 6, 9, and 12.*)

(No. 42) **Panthera pardus fusca** (Meyer)

## The Indian Panther or Leopard

Heard roaring, frequently, both by night and by day, and numerous tracks seen. (*See also Reports Nos. 9, 10, and 12.*)

(No. 56) **Herpestes smithii zeylanicus** Thomas

## The Ceylon Ruddy Mongoose

Several seen but none shot. (*See also Report No. 10.*)

(No. 60) **Melursus ursinus** (Shaw)

## The Sloth Bear

Numerous fresh tracks and diggings were observed, in the forest, but no bears were encountered. (*See also Reports Nos. 10 and 12.*)

(No. 88) **Lepus nigricollis singhala** Wroughton

## The Ceylon Black-naped Hare

Hares were frequently seen but none were shot. (*See also Report No. 12.*)

(No. 89) **Bubalis bubalis bubalis** (Linné)

## The Wild Buffalo

Several small herds were seen in various parts of the reserve and some fresh tracks of solitary animals. One bull was shot, from a herd of about twenty. It was in very good condition. (*See also Report No. 12.*)

(No. 90) **Muntiacus malabaricus** Wroughton

## The South Indian Barking-Deer

Several were seen in the heavy forest and around the breached tanks, but none were shot.

(No. 91) **Axis axis ceylonensis** Fitz.

## The Ceylon Spotted Deer

Literally hundreds of deer were seen, chiefly in herds of from a dozen to over fifty. Many stags were in velvet, or had just dropped their antlers. A fair percentage had renewed their antlers while others had not yet shed them. A few fawns were observed. Several stags were shot, the best antler measuring  $30\frac{1}{2}$  inches. (*See also Reports Nos. 10 and 12.*)

(No. 93) **Rusa unicolor unicolor** (Kerr)

## The Sambhur

Many tracks were seen, but the majority of stags were, presumably, in heavy forest. One hind, with a quarter-grown fawn at heel, was seen on several occasions. (*See also Reports Nos. 10 and 12.*)

(No. 95) **Sus cristatus cristatus** Wagner

## The Indian Wild Pig

Many small sounders and several solitary boars were encountered. One or two were shot. (*See also Report No. 12.*)

(No. 96) **Elephas maximus zeylanicus** Blain

## The Ceylon Elephant

Several small herds were observed in the distance and one or two solitary bulls were encountered, but elephants did not appear to be so numerous as usual in this reserve.

## (Report No. 14 continued.)

Collection	...	...	No. 19
Locality	...	...	Yala and Katagamuwa, Southern (Palatupana)
			Resident Sportsmens' Reserve, Southern Province.
Altitude	...	...	Approx : 10 feet to 50 feet above Sea-level.
Date	...	...	February 9 to 18, 1936.
Collected by	...	...	Mr. A. C. Tutein-Nolthenius and collector Wm. Perera

(*See also Reports Nos. 3, 6, and 12 on the same locality.*)

Mr. A. C. Tutein-Nolthenius again visited the Southern Resident Sportsmen's Reserve, during February, 1936, taking with him a collector and trapping as many small mammals as time would allow. The present small collection is chiefly useful as a supplementary collection to those made in 1931 and 1933. No new species appear in it, but the additional specimens of *Millardia meltada meltada* and *Leggadilla fernandoni* will be useful, as will also those of the Palm Squirrels, when this difficult group comes to be critically re-examined.

For a detailed description of the country, in which the collection was made, see Report No. 3, of this series. *Ceylon J. Sci.* (B) Vol. XVI, Pt. 3 dated March 18, 1932.

(No. 66) **Funambulus palmarum** (sub-sp.)

The Ceylon Palm Squirrel

1 ♂, 2 ♀♀. Talgasmankada. 1 ♀ Katagamuwa. 1 ♀ Yala.

All these specimens have the median stripe white and the outer stripes light buff. One of the females (from Talgasmankada) has a grey head with no sign of a reddish cap, but the remainder have a distinct reddish cap. The male has the head grey with no cap. None of them answer to the typical description of any of the four described races. They would appear to be intermediate between *kelaarti* and *favonicus*. The Palm-squirrels of the south and certain areas of the east of the dry zone are very puzzling, and until a large series from all parts has been collected, it is impossible to assign them, with any certainty, to any particular race. The present specimens will be useful for future research. (*See also Reports Nos. 11 and 12.*)

(No. 73) **Tatera ceylonica** Wroughton

The Ceylon Gerbil or Antelope Rat

1♂, 3 ♀♀ (1 sub-adult) Katagamuwa. 1 ♂, 4 ♀♀ (1 sub-adult) Yala. 1 ♀ Villapallewewa.

A fine series of typical specimens. It is noteworthy that the sub-adults are rather darker, in general hue, than the adults. Gerbils are very numerous in this area, the sandy soils suiting their requirements admirably. (*See also Reports Nos. 3, 4, 9, 10, 12, and 13.*)

(No. 76) **Rattus rattus kandiyanus** (Kelaart)

## The Common Ceylon House Rat

1 ♂. Talgasmankada.

A typical white-bellied specimen. (*See also Reports Nos. 2, 3, 6, 8, 9, 10, and 12.*)

(No. 79) **Millardia meltada meltada** (Gray)

## The Soft-furred Rat

1 ♂, 1 ♀. Katagamuwa. 2 ♂♂ (both sub-adult), 1 ♀. Talgasmankada. 1 ♂ (sub-adult) Villapallewewa.

A useful series of typical specimens. The three sub-adult specimens show that the soft fur increases in length with age. This rat appears to be common in the jungles and swamps of this area. (*See also Reports Nos. 3, 6, and 12.*)

(No. 79A) **Leggadilla fernandoni** Phillips

## The Ceylon Spiny-Mouse

3 ♂♂, 1 ♀. Katagamuwa. 1 ♂. Villapallewewa.

A small series of typical specimens, with the exception that the fur of the female is very short and fine and lacking in spines. This would appear to be due to youth. The fur, most probably, becomes more spinous with age, the young having quite soft and fine fur. This mouse appears to be common over the whole of the Reserve. (*See also Reports Nos. 2, 6, 9, and 12.*)

(No. 81) **Leggada booduga fulvidiventris** (Blyth)

## The Ceylon Field Mouse

2 ♂♂. 1 ♀. Yala.

Three typical, short-furred specimens. This species does not appear to be nearly as common in this area as the Spiny-mouse. (*See also Reports Nos. 2, 4, 10, 12, and 13.*)

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## The Type of *Semnopithecus thersites* Blyth

BY

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(With One Plate)

As I am preparing an account<sup>1</sup> of the prenatal development of the Crested or Grey Langur,—the large light-coloured Leaf-monkey of the northern and eastern parts of Ceylon,—I have had occasion to make certain of the exact taxonomic status of this form. In the latest revision of the Langurs of British India and Ceylon, the South Indian and Ceylonese animal has been treated by Pocock (1928) as a subspecies of the Indian *Entellus* Monkey. In a later paper (1929) he separated the Ceylonese from the Madras form and appended to the former the name *thersites* in a subspecific sense.

This name was first used by Walter Elliot in manuscript, but Blyth in 1847 used it for an animal whose skin was sent to him from Ceylon by Templeton, who had obtained it near Trincomalie. This was regarded by Blyth as a representative of a different species from the ordinary Ceylonese animal chiefly on account of the absence of a crest. Blyth gave a coloured figure of his *thersites* on Plate LIV alongside *entellus* and *priamus* (his name for the ordinary crested langur of South India and Ceylon). *Thersites* was figured as larger than *priamus* but slightly smaller than *entellus*. It was darker than *priamus*, especially on the back, hands and feet. The buttocks and backs of the thighs were pale, as in typical *priamus*. The whiskers were shown better developed, with a forward sweep on the chin, giving the effect of a short beard. The brow-fringe was also more marked. This latter feature, and also the increased size was also given prominence in Wolf's plate which forms the frontispiece to Tennent's *Natural History of Ceylon* (1861).

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<sup>1</sup> See pp. 211-251 in this part.



For a long time no one was sure whether *thersites* was a variety of the crested animal or a local race of the Purple-faced Monkey. Most authors regarded it as an individual variation of the Entelloid; but Blanford (1887) seems to have come to the conclusion that it was related to the Purple-faced Monkey because Blyth in 1881 had denied the presence of a frontal whorl. This latter view carried little weight, for, on geographical grounds the Purple-faced Monkey was not then known to occur in that part of the Island where Templeton had obtained his specimen. We now know however, that the *vetulus* monkeys do reside there.

Accordingly, some years ago, I took the step of having the original type of Blyth's *thersites* sent to me from Calcutta so as to determine once and for all what species of Ceylonese monkey it was most nearly related to.

My conclusions, which can easily be confirmed by a glance at the accompanying plate, were that it was, as most authors, other than Blanford, had suspected, an Entelloid Langur differing from the ordinary type found in the dry zone of Ceylon, only in the fact that the crest is not manifest, the top of the head being flattish like that of the North Indian Entellus. There is no suggestion, as Blyth pointed out, of a transverse raising up of the hairs normally seen in typical *entellus*, but there is a distinct suggestion of the longitudinal crest normally manifest in *priamus*, though it is not raised up to a peak as in normal individuals. Beyond this, however, the general form of the animal, its coat colour (though much faded), the presence of a well developed, forwardly projecting brow fringe, and lastly, though denied by Blyth (1851), the presence of a radiating arrangement of the hair on the frontal region, all bespeak of the necessity of relegating it to the genus *Semnopithecus* and not to *Kasi*. The skull, too is that of the former genus.

As this specimen is, therefore, undoubtedly only an individual variation of the Grey Langur, and since other isolated crestless or partially crestless individuals have since turned up in various parts of the Island, the name *thersites* becomes obsolete as a specific title, but is available as a subspecific name for the Ceylonese animal, if it is to be distinguished from the Madras form, as is done by Pocock (1929).

The value of the crest as a specific or subspecific character in the genus *Semnopithecus* has been disparaged in recent years on the strength of the above specimens. As this question enters into the subject-matter of my forthcoming paper, I thought it best to publish the present note as a preliminary thereto.

The type of *Semnopithecus thersites* Blyth is represented in the accompanying plate.

I am indebted to the authorities of the Calcutta Museum for the loan of this type, which was lent through the intermediacy of Dr. J. Pearson, at that time Director of the Colombo Museum.

#### REFERENCES TO LITERATURE

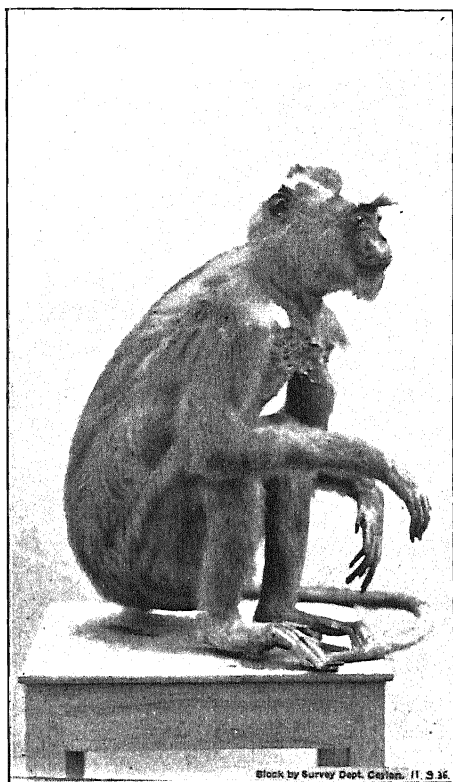
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#### DESCRIPTION OF PLATE VII

Photograph of the type skin of *Semnopithecus thersites* Blyth from the Calcutta Museum (January, 1933)

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Type of *Semnopithecus thersites* Blyth



## The Pre-natal Development of the Grey Langur, *Semnopithecus priam thersites*

BY

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(With Five Plates and Six Text Figures)

As far as I am aware no complete account of the intra-uterine development of any species of monkey has so far been published. There are numerous contributions relating to individual stages in several species. The best known of these are Selenka's (1901) descriptions of various stages of several Oriental monkeys; Schultz's account of foetuses of *Alouatta* and *Colobus* (1921 and 1924) and J. P. Hill's figures of foetal stages in his Croonian lectures (1932). Selenka's series was a complete one, but was made up of stages from numerous species, including some anthropoid material, besides macaques and leaf-monkeys. He compared his series with corresponding stages in human development. Schultz's specimens were limited to three foetal stages of *Colobus* and two specimens (twins) of *Alouatta*. J. P. Hill's contribution dealt mainly with placentation, the foetal material being introduced merely in passing. In addition to the above, de Beaux (1917) has described isolated specimens of advanced or full-term foetuses of *Cercopithecus*, *Mandrillus* and *Colobus*. Only Selenka's series therefore included any of the Asiatic leaf monkeys, and even there the species dealt with in the present communication was unrepresented. An account of a full term hybrid foetus between this species and the Purple-faced monkey (*Kasi vetulus*) has recently been published by the present author (1936).

Having now obtained a tolerably complete series of stages of the intra-uterine development of the Ceylonese Grey Langur (ranging from the blastocyst stage up to full-term), I set forth below my observations thereon. A few preliminary remarks on the position and status of this monkey are necessary.

## SYSTEMATIC POSITION OF THE GREY LANGUR

The Ceylonese Grey Langur with well-marked crest, until separated by Pocock in 1929, had always been considered as identical with the crested langur of the Coromandel coast of South India, both being somewhat loosely referred to as the "Madras Langur". It was regarded as a distinct species from the *Entellus* Monkey of North India on the strength of the crest on the vertex, different coat colour, and pallid hands and feet. As regards the last character, it was true that in the centre of the Deccan were to be found intergrading specimens with less pallid hands and feet, though decidedly darker than those of the Madras animal; but the same could not be said of the state of the crest. This was accepted as a stable character sharply demarcating the southern from the northern species until Blyth (1847) described his *Semnopithecus thersites* on a skin from Ceylon sent to him by Templeton, and differing from the ordinary Madras Langur in the absence of a crest. Numerous controversies, into which Anderson (1878) and Blanford (1887) entered freely, raged around this form. Its status was left in confusion, and, for many years, no one seems to have known whether *thersites* was an Entelloid or a variety of the Purple-faced Leaf-monkey.

Blanford (1887) favoured the latter view; but most writers took it to be an abnormal Madras Langur with absent crest due to individual peculiarity or to seasonal shedding. The value of the crest as a taxonomic character thus fell into disrepute, and Pocock (1928), on this and other grounds, treated it as of no importance in his revision of this group. Later (1929) in separating the Ceylonese from the Coromandel race, on the strength of colour differences, he revived the name *thersites* as a subspecific appellation for the crested Langurs of Ceylon and Travancore. He retained the invalid name *pallipes*<sup>1</sup> for the Coromandel Crested Langur. Both forms were regarded merely as races of *entellus* and the crest treated as an unstable character. In his former paper he had pointed out the existence of other crested Langurs in India, and tentatively treated all as subspecies of *entellus*.

The present position is, therefore, that all the Indo-Ceylonese Leaf-monkeys, other than the Purple-faced group, are treated as one polymorphic species named *Pithecus* or *Presbytis entellus*. Pocock (1935) has, however, suggested that the genus should be split up and the Entelloids to form a separate genus, probably requiring the name

<sup>1</sup> The name *priam* (Blyth 1844b) must stand as the specific title of the Coromandel Crested Langur, as pointed out by Flower (1929), "*pallipes*" (Blyth 1844a) being a *nomen nudum* (published minus a description).

*Semnopithecus*. Phillips (1935) had meanwhile adopted this name in a subgeneric sense on my suggestion, but since then I have raised (Hill, 1936a) the Purple-faced group to full generic rank and *Semnopithecus* will therefore also have to be promoted.

My studies on the Entelloids are far from complete, but as far as they have gone it has seemed to me that the numerous subspecies that have been described are not all of equal status. The crested southern forms, for example, are more sharply separated from the northern forms and from the Malabar races of the *hypoleucos* type than these are from one another. This suggests that variations of different order are all given the same rank. It would be better to treat the major differences as specific and the minor as subspecific in the present state of our knowledge. Probably it will be necessary to go back to Blyth's four main species, *entellus*, *schistaceus*, *hypoleucos* and *priam*, each with several sub-species<sup>1</sup>. As far as the last-named of these is concerned, my impression, gathered from a study of the adults, receives ample support from my observations on the foetal material described in the present contribution. I propose, therefore, to treat *Semnopithecus priam* as a full species with the Ceylonese and Travancore race entitled *S. p. thersites*.

#### MATERIAL

The specimens on which the following account is based consist of embryos and fetuses of *Semnopithecus priam thersites* collected in the North-Central and Central Provinces of Ceylon. Most of them were collected by Mr. W. A. L. Schofield and were fixed immediately after death. The younger stages were fixed in Bouin's fluid, and the older ones in 10 per cent. formalin, after making an incision through the abdominal wall.

#### Stage I. Blastocyst Stage

The earliest stage so far recovered is an embryo in the blastocyst stage still *in situ* in the uterus. It was collected at Sigiriya (C. P.) November 1933 by a Colombo Museum collector. From the size of the placenta the specimen appears to be older than the youngest stages in *Nasalis* and *Semnopithecus*, recovered and described by Selenka (1901) and redescribed by J. P. Hill (1932). It resembles the ovum of *Macaca irus* (Keim Ca of Selenka's series) portrayed in fig. 20a in J. P. Hill's

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<sup>1</sup> This is further rendered necessary in view of the recording of more than one "subspecies" from the same locality.



monograph, though the present specimen is much bigger. The following table illustrates the degree of uterine enlargement reached in the present stage :—

TABLE I—*Comparative measurements of the Uterus in the resting and early pregnant stages of Semnopithecus priam thersites*

Measurement	Normal Uterus mm.	Blastocyst stage of pregnancy. mm.
Max. height of uterus (fundus to external os)	38	50
Max. breadth	28	28
Max. thickness	9	25
Ht. of uterine cavity (fundus to internal os)	18	22
Breadth of cavity	14	15
Thickness of uterine wall	5	13

The above measurements indicate that the uterus becomes more globular in shape from the enlargement of the contained ovum, the height being increased and the antero-posterior extent relatively more so, but the transverse measurement increases very little. The thickness of the wall in this stage has increased to more than double its resting thickness.

The cavity of the uterus is still flattened antero-posteriorly, and both dorsal and ventral walls are occupied by sub-circular placental discs which cannot be pulled off. The intervening parts of the uterine wall are clothed with thin, transparent trophoblast, easily stripped, and exposing beneath a smooth endometrium, upon which the open mouths of uterine glands can readily be seen with the dissecting microscope.

The placental discs in the preserved specimen are dull opaque greyish in appearance and spongy in consistence, with an irregular free surface from which coagulated fluid can be scraped. The larger disc, presumably the primary one, situated on the ventral wall, measures 14.5 mm. in diameter, the total diameter of the chorionic sac being only 15 mm. No vessels or other structures can be made out on the discs with low power magnification. The discs are raised to a height of 3 mm. above the surrounding endometrium. The microscopic details concerning the placentae and the embryonic rudiment of this specimen are outside the scope of the present contribution.

The ovaries in this specimen were slightly increased above the normal in size. The right ovary measured 15 mm. long and the left 16 mm.

The former was occupied by a large corpus luteum, 5 mm. in diameter. The latter was occupied by a large cyst. In a non-pregnant animal the ovary measured 13 mm. long.

### Stage II. The 9 mm. embryo (Plate VIII, fig. 1)

The second stage in the present series is an embryo of 9 mm. total length (no. P.E. 10). It is represented in Plate VIII, fig. 1. It was obtained at Kala-o-ya, N. C. P. on January 1st, 1935.

The embryo appears less advanced in development compared with the human embryo, than would be expected from its length. This is because the embryo is relatively longer and thinner than the human embryo at the corresponding stage. Developmentally, the present specimen appears to represent a stage corresponding to that of the 5.5 mm. human embryo (*i.e.*, the fifth-week stage).

This embryo is almost identical in state of development with Selenka's embryo Sr. (a Mitred Leaf Monkey, *Semnopithecus mitratus*  $\equiv$  *Presbytis aygula*, from Java). Selenka's specimen does not possess the spiral twist and further differs in having a knob-like termination to the tail, a better developed olfactory pit, and a more prominent post-umbilical region. The number of mesodermal somites and the state of development of the limb buds is identical in the two embryos.

The embryo has a spiral twist on its axis. The twist commences just caudal to the anterior limb buds, the curve of the back arching over to the right and then forwards, caudally and to the left, ending with the tail pointing anteriorly on the left side.

The neural tube has completely closed and all the mesodermal somites appear to have developed. The fore-brain vesicle is squared off anteriorly and separated from the hind-brain by a right angled mesencephalic flexure. The dorsal edge of the hind-brain is a straight line and terminates behind in a rounded right-angular cervical flexure. From here the back is relatively straight as far caudalwards as the anterior limb buds, beyond which the spiral twist occurs as outlined above.

The first few somites are indistinct. They commence over the posterior branchial arches. What appears to be the fourth somite is the first well-defined one. There are three such somites anterior to the fore-limb bud, six opposite the bud, making twelve in all thus far. Thirteen somites appear between the anterior and posterior limb buds, three more (very broad ones) opposite the latter and fifteen between their hinder margin and the tip of the tail. I estimate, therefore, the

total number as forty-three somites as compared with the three occipital and thirty-five trunk pairs in man (Keith). The tail is relatively somewhat longer than in the human embryo at the same stage. Its tip is rounded and smooth and points, as already noted, forwards, lying on the left side as in man. Throughout the trunk region the smooth, cylindrical neural tube can be followed in the mid-dorsal line between the two rows of somites.

### *Sense organs*

On the under surface of the prominence of the fore-brain the olfactory placode can be distinguished, as a depressed plate on each side. A distinct groove connects this with the stomodaeum. The otic vesicle can be seen, by transparency, through the skin immediately dorsal to the cleft between the last two visible branchial arches. No evidence of the developing eye can be made out externally.

### *Stomodaeum and branchial arches*

The stomodaeum is wide and deep. By gentle force it can be opened. This procedure shows it to possess a broad, flat roof formed by the under aspect of the fore-brain. There is a depression on this in the mid-line well back,—evidently Rathké's pocket. The lateral margins are formed by the two maxillary processes which have apparently only just differentiated. The mandibular processes have grown forwards and appear to have recently fused. Their anterior margin is notched in the mid-line, but there is no such notch behind. The tongue rudiment can be seen in the form of bilateral swellings on the postero-dorsal part of the mandibular process.

Besides the mandibular process, there are only two visible branchial arches on the right side. A fold of ectoderm, apparently hiding a small third arch, has its free margin parallel to the hinder edge of the second arch. On the left this fold is less advanced, leaving a small triangular part of the surface of the third arch open to view.

### *Limb buds*

The anterior limb buds are well in advance of the posterior pair developmentally. The anterior pair have the form of flattened, flipper-shaped objects laid closely against the sides of the embryo's trunk. Their longest axis points posteriorly in line with the groove between the mesodermal somites dorsally and the pericardium ventrally. Their length is about that of the pericardium. Their maximum breadth is

three-quarters of their length; but the breadth at the site of attachment is only half the maximum breadth. The free margin is sharp and shows no indication of digits.

The posterior limb buds form a couple of elongated oval swellings, just ventral to the mesodermal somites at the hinder end of the trunk. They extend over three broad somites only.

#### *Trunk*

Between the two anterior limb buds, and also extending forwards to touch the ventral surface of the head, is the large pericardium, through which the atrial and ventricular portions of the heart can be readily seen, separated by a sulcus running from right to left and slightly caudally. The ventricular swelling is more opaque than the atrial.

Behind the above, the ventral surface of the trunk is further swollen somewhat by the liver. This, however, is not yet large. It occupies an antero-posterior extent somewhat less than the length of the fore-limb bud. The rest of the ventral surface, between the liver and the hind-limb buds, is taken up by the umbilicus, which is thus relatively narrow.

Summarizing the above account of the 9 mm. stage, it is clear that the embryo presents features usually associated with the fifth week of development in the human embryo.

### **Stage III. The 15 mm. embryo (Plate VIII, fig. 2)**

An embryo of 15 mm. crown-rump length (no. P.E. 9) was removed from a female shot in January 1935 at Kala-oya, N. C. P. This stage proves to be, in all essential particulars, similar to a human embryo of the same length. The disproportion noted in the previous stage has been overcome by the increased dorsal curvature, and the relative shortening of the region between the limb buds. The embryo, however, can be identified as that of a monkey on account of the inordinate length of the tail, which, in a human embryo of corresponding age, has already begun to regress.

#### *General form*

The head takes up almost half the total bulk of the embryo. It is markedly flexed on the trunk, and upon it the cephalic and cervical flexures are still rectangular. Between the two, the surface of the head is slightly depressed on account of the formation of the pontine flexure on the brain stem. A depression, in the position of the future 'neck', marks off the head from the region from which the anterior

limb bud takes its origin. The back is slightly curved dorsally as far as a point just beyond the hind-limb buds, whence it takes a sharper bend to the tail, which now points ventrally along the umbilical cord. No division between neural tube and paraxial mesoderm can now be made out, except on the tail.

### *Head*

Approximately three-quarters of the head is made up of brain. The blunt anterior end is formed of the prominent fore-brain, and mid-brain. The former grows forwards and hides most of the face from view. The dorsal margin of the head is formed by the rest of the mid-brain and by the hind-brain.

The face resembles in general that of a human embryo of the eighth week, but there are minor differences. The eyes are large, the cornea extensive, and the iris pigmented. The eyelids are small curtain-like folds, insufficient to cover the globe or even the sclerotic. The eyes are set wide apart, and look as much outwards as forwards. The interocular region is thus broad and flat. Above and slightly medial to the eyes is a row of small tubercles, about six in number,—the anlagen of the eyebrows. Some similar tubercles occur on the upper lip, and sharply distinguish the monkey embryo from that of man.

The nose is flat, and the nostrils look forwards. In outline they are triangular with medial, superior and infero-lateral margins. The medial and superior margins are produced forwards as sharp lips, but the infero-lateral margin is less pronounced. The internarial septum is wide, but of even breadth from above down, since the medial border of each naris is perpendicular. The upper lip is fully formed, but notched in the mid-line on its free margin. The lower lip is entire. The cheeks are indented by pressure from the hand-plates which lie against them. The oral slit extends laterally as far out as the outer canthus of the eyelids. It is impossible to see inside without dissection. Branchial arches are no longer visible, but the upper end of the first cleft persists as the external auditory meatus. This forms a funnel-shaped depression just anterior to the root of the fore-limb bud. It is guarded dorsally by a ventrally directed tongue-shaped fold of ectoderm,—the primordium of the pinna.

### *Limb buds*

These have advanced considerably beyond the stage observed in the 9 mm. embryo. The fore-limbs are more elongated and cylindrical, and the distal third has been flattened out and moulded into the

hand-plate. The wrist is therefore recognizable, but the elbow is not. Five digits are differentiating on the hand-plate, and their extreme tips are free, the rest being completely webbed. The pre-axial digit is very short and situated well up on the pre-axial border. The others are subequal in length. The axis of the main part of this limb is directed ventrally, but the hand is turned forwards to rest with its palmar surface on the fore part of the pericardium, and its dorsum in contact with the cheek. It reaches almost to the outer canthus of the eyelids.

The posterior limb buds are approximately one third shorter than the anterior pair, and are correspondingly less advanced in development. The proximal portion is cylindrical, with no indication of knee-joint. The distal part forms a flattened fan-shaped foot-plate, with but the faintest indication of the differentiation of digits, and no festooning at the free margin. In position this limb is directed ventralwards, with the plantar aspect of the foot-plate looking directly medially.

#### *Trunk*

The trunk has in this specimen attained a barrel-like form, the pericardial swelling being now overshadowed by the prominence caused by the liver, resulting in a smooth convexity extending from beneath the chin to the umbilicus. The umbilical cord is relatively short and thick, and already shows indications of spiral twisting. A loop of gut can be seen in its proximal end passing at least halfway along it. Between the hind-limb buds can be seen a large genital tubercle. The proximal part of this is cleft below, the edges of the cleft forming raised lips. These lips pass backwards and surround the cloaca. The sex cannot be distinguished by external examination.

#### **Stage IV. The 24.5 mm. embryo (Plate IX, fig. 1)**

This embryo (no. P.E. 24) was obtained in January 1936 at Keki-rawa, N. C. P. It corresponds in development almost exactly with a human embryo of the same crown-rump length, and apart from the length of the tail and the form of the foot, is still practically indistinguishable therefrom.

#### *General form*

The embryo has now assumed a form which definitely stamps it as that of a Primate; for instance, it retains a large head, with disproportionately large cranium, and its hands and feet are of definite

Primate form. In none of these features can it yet be distinguished from any other Primate. The length of tail is the only character against it being human or simian, and stamps it at once as that of a monkey.

The general contour is now smooth. The flexures of the brain stem have been rounded off, and the growth of the gut has caused the pericardial and hepatic prominences also to be smoothed out. There is the beginnings of a neck produced as a result of the lessening of the flexion of the head on the thorax. There is no external demarcation between thorax and abdomen. The umbilicus takes up as much room as in the last stage.

TABLE II—*Body measurements of a series of Pre-natal Stages of the Grey Langur (Semnopithecus priam thersites)*

Measurement	P.E. 24	P.E. 23	P.E. 22	P.E. 20	P.E. 25	P.E. 26	P.E. 27	P.E. 19	P.E. 28	P.E. 18
Crown-rump length in normal foetal pose	24.5	54	75	120	120	130	130	135	145	168
Sitting height in extension	24.5	55	90	145	145	160	165	175	180	180
Tail length	12	37.5	89	165	162	210	196	245	220	260
Thoraco-abdominal ht. (suprast.-symph.)	13	27	42	68	65	88	85	75	92	78
Symphysion-thelion	—	23	34	56	56	71	70	64	76	64
Symph.-omphalion	4.5	11	17	20	20	28	30	30	28	32
Bisacromial br.	7	12	23	40	36	43	46	48	48	58
Bimammillary br.	—	5	10	15	10	18	13	17	14	19
Bitrochanteric br.	6	11	20	35	32	35	36	41	38	43
Trans. diameter of thorax	7	8	21	29	32.5	34	39	38	37	45
Sagittal do.	8	13	23	31	32.5	34	39	36	38	47
Circumf. of thorax	22	35	68	120	110	115	129	130	130	194
L. of Brachium	5.5	13	23	41	40	50	50	54	51	62
L. of Antebrachium	5	10	24	41.5	39	50	50	51	54	62
L. of Hand	5.25	11	18	38	35	43	44	42	42	48
L. of Thumb	1	3	2	4	6	7	8	4	7	6
Br. of Hand	2.5	3	7	11	12.5	15	16	16	17	19
L. of Thigh	5.5	12	24	42	43	50	56	53	52	56
L. of Crus	5	12	22	42	43	50	58	53	58	58
Malleolare-sole	—	1.5	5	5	5	6	8	8	9	10
L. of Foot	3.5	10	24	46	43	56	58	62	62	68
Br. of Foot	2.5	3	6.5	14	11	15	16	15	16.5	17
Glabella-Max. occipital point	11	18	30	50	50	57	59	58	59	65
Max. cranial br.	8	16.5	26	41	42	47	47	47	50	52
Auricular ht.	8	15	20	30	30	30	38	37	38	35
Nasion-inion	10.5	18	29.5	49	48	55	56	55	58	62
Biauricular br.	8	15	26	40	42	45	46	49	46	57
Circumf. of Head	28	55	90	150	145	170	167	177	167	194
Sagittal arc	23	36	54	75	80	85	91	89	97	100
Transverse arc	20	35	55	75	85	96	108	97	110	112
Total head height (gna-thion-vertex)	9	19	30	47	46	50	51	52	54	59
Total facial ht.	4	8	18	25	27	28	28	27	31	31
Upper facial ht.	3	6	13	18	21	21	19	20	22	23
Bizygomatic br.	7	13	20	32	31	35	36	36	37	41
Nasal ht.	1.5	4	9	16	14	15	14	18	17	15
Nasal br.	2	4	7	10	10	11	12	12	12	13
Septal br.	1	2	4	5	4	5	5	5	6	6
Interocular br.	4.5	5	7	9	8	9	11	11	11.5	13
Br. of Mouth	3	6	10.5	18	20	18	20	18	21	22
Ear length	2	5	10	19	20	21	20	23	25	30
Ear breadth	2	3	6	14	14	16	16	16	20	21

TABLE III—Indices<sup>1</sup> of a series of Pre-natal stages of the Grey Langur (*Semnopithecus priam thersites*)

No.	Index.	P.E. 24	23	22	20	25	26	27	19	28	18
1.	Tail-index	200	146	101	88	89.5	76	84	71.5	81.5	69
2.	Relative bisacromial index	54	44.5	54.5	59	55.5	49	54	63.5	52	74
3.	Rel. bitrochanteric index	46	40.75	47.5	51.5	49	39.5	42.25	54.5	42	55
4.	Rel. circumference of thorax	170	130	162	176	176.5	131	141	173	141	210
5.	Thoracic index	87	57	91	93.5	100	100	100	106	97	96
6.	Rel. binmamillary	—	62.5	47.5	51.5	31.5	53	33.5	45	38	42.5
7.	Rel. position of nipple	—	85	81	82.5	88	79.5	82	85	83	82
8.	Rel. position of umbilicus	34.5	40.5	40.5	29.5	31	32	35.25	40	30.5	41
9.	Rel. length of upper limb	125.8	126	154	178	190	162	170	180	155	220
10.	Humero-radial index	91	78	104	101	98	100	100	95	106	100
11.	Forearm-hand index	105	110	75	92	90	86	88	82.5	78	78
12.	Hand index	47.5	27.25	38.75	29	35.75	34.75	35.25	38	40.5	39.5
13.	Rel. length of lower limb	81	94	121	131	140	120	141	152	129	159
14.	Femoro-tibial index	91	100	92	100	100	100	100	100	90	103
15.	Leg-foot index	70	83	109	109	100	112	104	117	107	117
16.	Intermembral index	150	133	127	147	158	135	120	129	125	139
17.	Femoro-humeral index	100	108	95.75	95.5	93	100	89.5	102	98	111
18.	Tibio-radial index	100	83	109	98.5	91	100	89	96	93	107
19.	Foot-hand index	150	110	75	80.5	81.5	77	76	68	68	71
20.	Rel. size of head	121	96	94	89	92	103	97	62	52	63.5
21.	Head-trunk index	69	48.5	60	60	62.5	50	55	81	85	80
22.	Cephalic index	73	92	87	82	84	82.5	80	64	61	54
23.	Length-height index of head	83	83	68.5	60	60	53.5	64.5	61.5	60	62
24.	Sagittal-vault index	45.5	50	54.5	65.5	60	64.5	61.5	61.5	33.75	39.75
25.	Face-trunk index	31.75	31.75	42.75	36.75	41.75	31.75	30.75	36	13.8	13.2
26.	Rel. size of upper face	10.5	11.3	15.3	13.7	15.7	14	12.5	12.8	8.5	88
27.	Vert. cephalo-facial index	50	53.25	90	83	90	93	68	73	59.5	56
28.	Upper face index	43	46	65	56	68	60	53	74	77	65.5
29.	Rel. nasal ht.	50	50	39	89	52	53.5	53.5	66.5	70.5	87
30.	Nasal index	133	100	78	63	71.5	73.5	86	67	31	31.75
31.	Rel. interocular br.	64	38.5	35	28	25.75	25.75	30.5	30.5	80	70
32.	Ear index	100	60	60	73.5	65	76	80	69	15.8	16.54
33.	Rel. size of ear	4.05	4.4	6.65	11.3	12.2	11.8	10.7	13	15.8	16.54

<sup>1</sup> The indices are calculated according to the suggestions made by Schultz (1924) and as used also in the present author's recent publication (1936b).



*Face*

The facial features are not much advanced beyond the 15 mm. stage. In outline the face is squarish. The forehead is relatively low, but still bulged forwards somewhat. The upper jaw projects considerably beyond the lower, and the latter is narrow, being only half as deep as long. The eyelids are now fully formed and completely cover the globe. They are limited by a sulcus from the rest of the face, both above and below. The eyebrow rudiments are no more advanced than at the 15 mm. stage. The globe now looks more forwards than outwards, but the interocular region is still broad and but little depressed. The nose is broad and flat, but the outlines of the nares are now distinct, reniform, with the concavity medially, and separated by a broad internarial septum, which is not appreciably narrower below than above. The mouth is a transverse slit extending laterally as far out as the palpebral fissure. The lips are entire, with smooth borders; the chin is squared off. The cheeks are more prominent and rounded. The external auditory meatus is hidden by the further growth of the pinna. The primordial triangular flap mentioned in the preceding embryo has now enlarged ventrally, and is supplemented by a rudimentary tragus and another triangular tubercle between the two posteriorly, no doubt an antitragic rudiment.

*The neck*

This is now distinct, and allows the head to be raised from the surface of the chest.

*Limbs*

The limbs show considerable advance in development over the 15 mm. stage. The fore-limbs show further elongation and joint-formation. The elbow is now evident, and the hand plate has given rise to the digits. These are of simple Primate form, and do not yet exhibit the specialized elongation which is characteristic of the *Presbytinae*. The thumb, however, is very short, as in the adults of this subfamily. The digital formula is  $\text{III} > \text{IV} > \text{II} > \text{V} > \text{I}$ . The middle and annularis fingers are almost of equal length, and the same applies to the index and minimus. The palms show no creases, but there are faint indications of palmar pads opposite the roots of the thumb and index. The digits themselves are relatively short, compared with the length of the metacarpal region. They are, however, quite free from one another. They are concave on their palmar aspect, except for the terminal portion, which appears to be rather suddenly

bent dorsally, due to the development of a ventral swelling. The region of the nail bed is flattened, but there is no visible rudiment of a nail.

The feet are of typical Primate form, with an elongated sub-triangular tarso-metatarsal region. The toes are shorter and stouter than the fingers. The first toe is the shortest and springs from the medial margin of the distal part of the foot. All the pedal digits are more flexed than those on the manus, the flexion on the hallux being in a plane at right angles to that on the remaining digits. The digital formula is  $IV > III > II > V > I$ . The ventral swellings mentioned on the fingers are less evident on the toes, whilst the nail beds are barely distinguishable.

#### *Trunk*

The trunk is still barrel-shaped, but is relatively more elongated. It is widest in circumference just anterior to the umbilical insertion, but tapers steadily both towards the neck and the tail. The anus is a transversely elongated depression immediately ventral to the tail-root. Some distance ventral to this is an anteroposteriorly elongated urogenital depression, with slightly swollen lateral lips and a ventral phallic tubercle. This is much larger than in the 15 mm. embryo, and consists of a proximal narrow portion and a distal swollen portion. It is not possible to distinguish the sex by external examination.

#### **Stage V. The 54 mm. Embryo. (Plate IX, fig. 2)**

This embryo (no. P.E. 23) was obtained in January, 1936, at Keki-rawa, N. C. P. It is twice the crown-rump length of the last stage, and, in practically all its measurements, is just double that specimen. This is indicated in table II.

In general form this embryo is similar to the last. It has a narrow elongated body, somewhat deeper dorso-ventrally than from side to side. The head is still large, but less relatively than in the preceding stage. Besides the increase in size, there are numerous indications of new structural developments. Most notable are the presence of the Anlagen of the hair follicles, which are visible in the translucent skin as small opaque spots regularly distributed all over the surface of the body. The nipples are also now visible. Other details are discussed under the regional headings below.

In size, this embryo corresponds to that of a human embryo of the eighth week, but developmentally it is advanced to a stage at least two weeks ahead of the human, and with regard to the state of its pilous system to at least twice that age.

The embryo is more decidedly Primate in its appearance than hitherto and there are some features now present that enable one to identify it as a Presbytnine monkey, provided one assumes it is a Catarrhine, which can probably be done on the narial features. If it is assumed to be an Old World monkey the proportions of the limbs to the trunk, and more especially the elongation of the hand and foot, are suggestive of Colobid affinities.

### *Face*

The face is more rounded in outline, and in general appearance more like a monkey than in any previous stage. The forehead is vertical and as high as the face. The brows are not prominent and the eye-brows are no more advanced than the other hair follicles. The eyes now face directly forwards and the globe forms a superficial prominence on the face. It is completely covered by the eyelids, which are now tightly fused along their margins. The nasal bridge is depressed, and the nose proper very broad. The nares are relatively larger than before and face forwards. The upper lip is deep, and the lower jaw reaches as far forward as the upper lip, but neither project as far as the nasal region. The upper jaw, therefore, has a convex outline when viewed from the side. The sinus hairs of the lips are no more advanced than the other hair follicles. The lips appear to be separated from the gums. The head is now more extended and the neck more obvious.

### *Ears*

The ears (see fig. 3a, p. 234) are considerably advanced beyond the stage last described. Each pinna now presents most of the main parts visible in the completely developed organ. The outline is that of a quadrilateral flap, with anterior (or attached), superior, posterior and postero-inferior borders. The anterior border is formed below by the tragus, which is broad and shallow. Above this is the commencement of the helix, which is broad from before backwards. Upwards, the latter passes through a right angled bend into the superior border, which it forms as far back as the postero-superior angle. This is the sharp angle separating the upper from the hinder borders of the organ. The helix can be traced just round the angle on to the posterior border, but here it soon fades out, the rest of this border being formed merely by the thin unmodified edge of the auricular flap. The postero-inferior angle limits this border below. It is a very obtuse angle from which the postero-inferior border passes obliquely downwards to the lobule. The latter is a very marked, slightly thickened part of the auricular

flap lying below the level of the tragus. It is limited above by the antitragus. The only other markings present on the flap are (i) a rudimentary fossa triangularis below the antero-superior angle of the helix and (ii) a very slight supratragal impression on the flap between the antitragus and the tip of the lobule.

### *Limbs*

The limbs are now more elongated and nicely rounded in circumference. The proportions of the various segments can be judged from the measurements in table II. The hand and its digits are now elongated. The thumb is relatively short, the digital formula being  $IV > III > V > II > I$ . The nail plates are well advanced and form superficial prominences on the dorsum of the terminal phalanges, and project some distance beyond their tips. There is a longitudinal palmar crease separating off the "ball of the thumb" from the rest of the palm, but no other creases. There are bulbous prominences (interdigital pads), three in number, at the roots of the fingers. Deep transverse creases separate off the fingers from the palm of the hand, and there are also transverse flexure lines on the digits themselves. (See fig. 4a and d.)

The feet appear to be as advanced in development as the hands, and not lagging behind as in Man. They are more elongated than the hands. The hallux is better developed than the thumb, and is well apart from the remaining digits. The digital formula is  $III > IV > II = V > I$ . Malleolar prominences are developed on each side of the ankle. There is a longitudinal crease, slightly less marked than on the hand, separating off the "ball of the big toe". There are three interdigital prominences at the roots of the toes as on the hand, but, except on the hallux, the transverse flexure lines are not well marked. The nails are as advanced as on the fingers.

### *Trunk and tail*

The trunk is longer and narrower than in earlier stages. It is especially narrow from side to side in the thoracic region. The abdomen is more rounded. Internally the liver is still very large and presents none of the specializations of the Colobidae. The stomach too is still of the simple pattern. The umbilicus is very restricted. The tail is long and coiled. At its tip is a narrow, kinked appendage. The anus is now relatively smaller, and with well-marked lips. The genital tubercle is enlarged and cylindrical. The glans is well differentiated and covered with a prepuce. But the orifice of the urethra is still visible at the root of this organ, so that it is not

possible to be certain of the sex. There is as yet no indication of ischial callosities. Nipples are indicated as already mentioned. They lie relatively close together on the ventral aspect of the thorax.

### **Stage VI. The 75 mm. Embryo. (Plate X, fig. 1)**

This stage (no. P.E. 22) was obtained in March 1935 at Kekirawa, N. C. P. Its size is half as large again as the preceding stage, but similar general proportions are maintained.

#### *General form*

The embryo is elongated and narrow compared with a human embryo of similar development. This is especially true of the trunk and limbs. It differs, however, from the previous stage in again becoming flexed in general posture. When extended it measured 90 mm. long. The thorax is relatively broader than before, but still deeper dorso-ventrally than from side to side. The integument is now no longer translucent, so that the hair follicles are not visible through it. The hair has not erupted from its follicles, with the exception of the brow hairs, the detailed arrangement of which is discussed below.

There is less discrepancy, at this stage, between crown-rump length and state of development than in the previous stage, when compared with the human embryo. A human embryo of this size would be at the thirteenth week of intra-uterine life, and would have the pilous system in much the same state of development as in the present monkey embryo. The limbs too would be similar, but the nails are more advanced in the monkey than in the human embryo.

#### *Face*

The face forms roughly a quarter the size of the cranial part of the head. It is rounded, as before, in outline, and has the same convex curvature in profile. The forehead is high and vertical. The brows are now more prominent and surmounted by a continuous line of dark hairs that have just erupted. The line is concave upwards in the mid-line, but becomes concave downwards over the eyes. Above the brows, the scalp hairs can be seen just thrusting their tips through the skin, but they are much finer than the brow hairs, and are unpigmented, so that it is not yet possible to make out the hair streams with certainty. The eyes are still large and cause prominent bulges on the face. They are still completely covered by the fused lids. The margins of the lid, however, are more definite, though there are no eyelashes. The interocular region is broad and quite depressed. There

is no interpalpebral sulcus, but there are sulci separating the eyelids from the brow region above, and the nose and cheeks below. The lower sulcus is double. The nose is much advanced and already differs from that of a macaque embryo of the same crown-rump length. The nares are similar in shape to those of the earlier stage, but they are now oblique in position with their lower ends approximated. The septum is therefore wide above and narrow below, but the lower narrow part fades away rapidly instead of being produced downwards on to the upper lip, as it is in the macaque. The whole area around the nares is inflated and more opaque than the rest of the skin of the face, giving an appearance like that of a Gorilla. This nasal swelling covers an area almost as large as the eyeball. It approaches below to within a very short distance of the free margin of the upper lip. The lips are entire, and are much thicker than in previous stages. Their free margins are already differentiated from the cutaneous superficial surface to form a mucous border. Beyond this margin hairs are more advanced in eruption than anywhere except the brows.

The ear has attained a definite pithecoïd form. It may be described as quadrilateral, with the corners rounded. There is a well defined helix passing along the upper part of the anterior border and along the upper border. This ends at the rounded-off upper posterior angle of the auricular flap. The rest of the borders of the flap are thin and unfolded. There is a well marked tragus anteriorly, but this forms a straight fold. It is separated by a sharp intertragic notch from the well developed antitragus. Behind and below the latter there is a rudimentary bursal depression. Below the upper anterior part of the helix is the commencement of an antihelix. The whole auricle is closely adpressed to the side of the head. The fossa triangularis and the cyma are mere linear sulci, due to the swollen state of the crura antiheliciis (fig. 3b).

### *Limbs*

The hind-limb is now definitely longer than the fore-limb. The forearm is slightly longer than the brachium, but the thigh is longer than the crus. The hand is not as long as the forearm, but the foot is longer than the thigh.

On the dorsum of the hand there is some slight granular pigmentation. This also passes some distance on to the forearm. There is, on the ulnar side of the base of the palmar aspect of the hand, a very prominent heel-like projection. It is limited all round by a sharp crease, especially distally. Other, rather less prominent, pads are

found, one forming the "ball of the thumb", and three others (interdigital pads) at the bases of the remaining digits. These are now separated from the rest of the palmar skin by definite creases. The thumb is very short and projects sideways from the radial edge of the hand. The other digits are well developed, the fourth being longest, the third slightly shorter, then the fifth and second in order. Their terminal phalanges are marked ventrally by bulbous processes upon which papillary ridges are already visible. These ridges form simple arches. Dorsally the nails are now well formed and project beyond the tip of the fingers.

The foot has attained the adult form. Pigment is present on the dorsum to the same degree as in the hand. On the plantar aspect, the pads and creases are less well marked than on the hand. The hallux is well separated and much better developed than the thumb. Its basal joint has a large pad. There are three interdigital pads opposite the bases of the other four digits, but only the one opposite the index is at all sharply separated off from the surrounding skin. The toes have bulbous pads on their tips, but these are less developed than on the fingers, and their papillary ridges are less well marked. The digital formula is  $III > IV > II > V > I$ .

### *Trunk and tail*

The trunk is now sturdier in build, though still having an elongated barrel-like shape. It is broader at the anterior than the posterior end, the latter being the more tapering. The broadening anteriorly is due to the increasing prominence of the shoulders. There are no axillary folds. The nipples are now more prominent and wider apart. The abdomen is full and rounded, due to the large size of the liver. The stomach is more visible on opening the abdomen than hitherto, but is still of simple form.

The perineal region is depressed, due to the lateral prominences of the ischia. There are as yet, however, no indications of callosities on the latter. The anus is a transverse slit. The sex is now distinguishable externally, the present specimen being a female. The clitoris is very small and curved, but presents a distinct glans and prepuce. There are no labia, the vaginal orifice opening immediately dorsal to the root of the clitoris. The genitalia are situated very close to the anus.

The tail is long and gradually tapers to its apex, but beyond this there is still present a short, filamentous kinked prolongation.

**Stage VII. The Foetus of 120 mm. (Plate X, fig. 2)**

This specimen (no. P.E. 20), which is best referred to as a foetus, was obtained at Kekirawa, N. C. P. in May 1935. It shows considerable advance in both size and state of development on the 75 mm. stage, and corresponds roughly with a human foetus of the fifth month of intra-uterine life, though, of course, the latter is larger than the monkey. It also corresponds with Schultz's youngest *Colobus* foetus. The monkey, however, in several respects is more advanced than the human foetus of corresponding age, as will be seen from the detailed account which follows.

*General form and proportions*

This foetus may now be recognized, readily, as that of a leaf-monkey by its generally slender form and elongated limbs. In posture it is more flexed than the previous specimen, but not so much as in the larger individuals described later in this paper. The head is flexed on to the chest; the back presents a uniform dorsal convexity; whilst the limbs are all semi-flexed.

The proportions can best be studied from the tables of measurements and indices. The trunk height is about double that of the preceding stage, and this remark also applies to the distance between the symphysis and nipples. But the distance from the symphysis to the umbilicus has increased but little, indicating that the insertion of the cord recedes towards the symphysis with advancing foetal development. The cord itself in this specimen is long (165 mm.) and thin. The trunk is increasing rapidly in breadth as indicated by the bisacromial measurement, and also, to a lesser extent, the bitrochanteric diameter. The brachium is almost double the measurement of the same part in the 75 mm. embryo, but the forearm has increased to a rather lesser extent. The greatest growth, however, is in the hand, which has increased in both breadth and length, but especially the latter. The thigh and crus have increased to much the same degree, but the foot has exceeded them in its increment in the same way as the hand. The head is less disproportionate in size than at any previous stage.

*Hair tracts (figs. 1 and 2)*

Perhaps the most striking advance in external features in the present stage is in the development and eruption of the general bodily hair. It is now possible to make out the hair streams all over the body with certainty, and in so doing it at once becomes evident that not only is the foetus determinable as that of a Presbytine monkey, but that



it is possible to identify the genus and species to which it belongs. The hair development is thus in advance of the *Colobus* of the same size as outlined by Schultz.

The brow hairs are the most advanced, and form an arched series projecting well forwards immediately over the eyes. On the face, hairs are scanty and short, but such as are present all point downwards. These include hairs along the median line of the nose, a few on the cheeks, and a rather more plentiful covering on the lips and chin. Those nearest the margin of the lower lip project forwards, but the remainder on both lips and chin stream directly downwards.

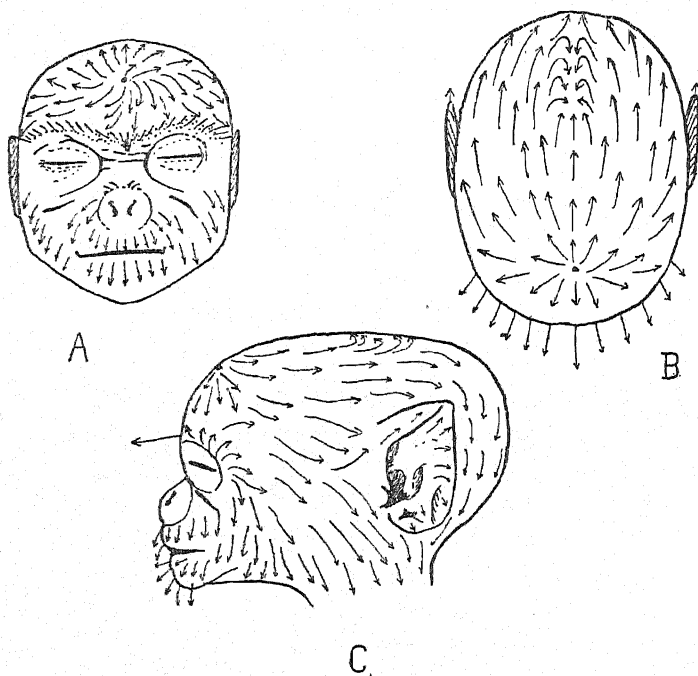


Fig. 1. Hair tracts on the head of a 120 mm. foetus of *Semnopithecus priam thersites*

(a) Front view, (b) Vertical view, (c) Lateral view.

On the crown, appear the hair arrangements which are of generic and specific importance, and the latter appear to distinguish the species *priam* from typical *entellus*. About 11 mm. behind the brows, is a centre of radiation from which the hairs proceed in all directions;

some forwards in line with the stiff brow bristles; some laterally and some directly backwards. The lateral streams gradually turn backwards and sweep past the ears to the back of the crown. Those near the middle line pass back over a distance of 25 mm. and then stop. Those just lateral to this, sweep back in a gentle curve for another 12 mm. and then turn sharply forwards again to meet, from behind, the already ceased mid-line tract. In this way the basic plan of the crest is laid down, though there is no manifestation of the crest on the lateral view of the head. This hair arrangement is a specific character for *priam*. The frontal radiation, on the other hand, is a generic character distinguishing the Entelloid Leaf-monkeys (*Semnopithecus*) from those with the more primitive cranio-caudad trend of the scalp hairs (*Kasi* and *Trachypithecus*).

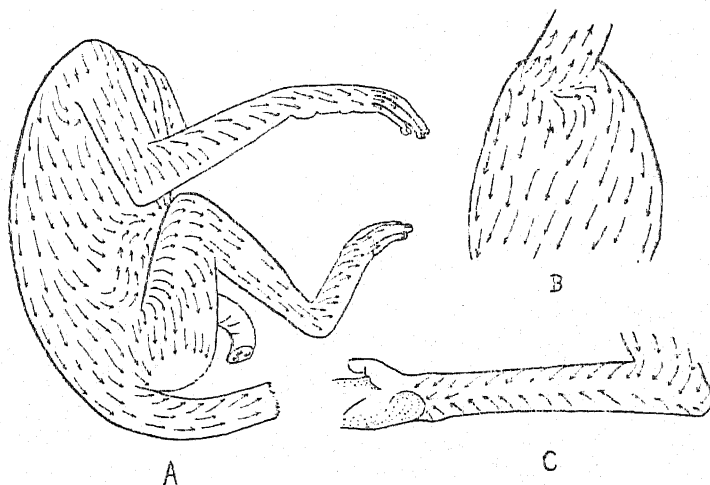


Fig. 2. Hair tracts on the body and limbs of a 120 mm. foetus of *Semnopithecus priam thersites*.

In the auricular region the hairs mostly stream backwards, diverging round the root of the ear to meet again behind it. Those on the lower part of the cheek point downwards, and more posteriorly downwards and backwards, to continue into the downward stream on the side of the neck. On the throat and neck all the hairs pass caudally. The same applies to the hairs on the back and tail, and also to those on the front of the chest. In the axilla the hairs are arranged radially, as shown at B in fig. 2. A rather simpler arrangement is seen in the inguinal region. The hairs from the flanks pass on to the thighs,

where they take a direction towards the postaxial border, and thence, at the upper part, on to the buttocks as far as the free margin of the ischial callosities. More ventrally, the flank hairs undergo a reversal as they approach the groin, and thus proceed towards the umbilicus. The latter thus becomes a convergence centre.

On the limbs the hair streams are relatively simple. On the brachium all the hairs proceed distally; but on the forearm there is a convergence towards the median line of the volar surface. On the dorsum of the hand, there is a tendency for the hairs to stream obliquely towards the ulnar border, except for those nearest the radial border, which stream directly distally. Hairs occur on all the digits dorsally as far forwards as the penultimate phalanges. On the thigh the streams on the lateral surface have been noted above. Medially the hair is very scanty over the region of Scarpa's triangle, but post-axial to this the hairs trend proximally towards the callosity, so that, with the previous stream mentioned above, the callosity is really to be considered as an enlarged, bare, convergence-spot. On the posterior aspect of the thigh most of the hairs pass proximally, but towards the lower end they become more oblique and are continuous below with the uppermost hairs on the calf region. These pass obliquely distally and backwards. On the rest of the calf the hairs trend directly distally. On the dorsum of the foot the arrangement is similar to that on the hand, *i.e.*, there is a trend towards the fibular border, except on the back of the first metacarpal, where the stream passes directly distalwards. The dorsum of the toes is haired as on the fingers. The hairs throughout the lower limb are less advanced through the skin than on the upper limb.

### Face

The face is of similar shape to that of the preceding embryo in this series, but now presents more expression, due to the development of many of the characteristic sulci and folds. The prominence of the stiff brow bristles has been noted above. Beneath these, in the interocular region, which is depressed, there occur a number of interpalpebral sulci. None of these passes completely across from one inner canthus to the other, as occurs in the foetus of *Colobus* described by de Beaux (1917), but each passes more than half way across the interpalpebral region. The eyelids are much more distinct than hitherto. Their borders are more clearly defined, but they are still firmly fused along the deeper parts of their free borders. Eyelashes are present,—long, but fine,—on both upper and lower lids. The eyeballs themselves are less prominent than hitherto, and accordingly do not project so far

forwards as the bony orbital margin. The circumpalpebral sulcus is therefore less pronounced than in former specimens. Apart from the eyelashes, the whole region is hairless. The interocular region is also hairless, except for a narrow median tract continuous above with the brow hairs, which descend lower in the mid-line than elsewhere.

The nose is similar to that of the previous stage, *i.e.* forming a raised circular pad, like that of a Gorilla. This raised area is more opaque than the rest of the facial skin. The pad slopes gradually on all sides. Between it and the interocular region are several short, radially arranged sulci. Other short vertical sulci limit the pad laterally. Below, the pad is prolonged slightly on to the surface of the upper lip, which is thus very shallow in the mid-line. The nares are elongated and more slit-like than in earlier stages. They lie nearer together below than above, forming an internarial angle of  $56^{\circ}$ . Each naris is more constricted in the middle than towards its two extremities. A few downy hairs project from within the nares.

The lips are clear cut and their surfaces relatively hairy. They are convex from above down. The mouth is closed, but the lips not fused. The chin is triangular in outline, but not prominent.

There is no pigment anywhere in the facial skin, but a diffuse light grey pigmentation occurs in the scalp, on the dorsal surface of the body, and certain parts of the limbs.

The ears are much larger and more like those of the adult. The whole pinna is more expanded than in previous stages, and has a rectangular outline, with upper, posterior and inferior borders, and superior and inferior angles. The superior angle is the more prominent, and corresponds to Darwin's tubercle on the human ear. The inferior angle is more rounded, and from it the inferior border passes obliquely to its attachment to the side of the head, but, before reaching this, there is a small expansion, representative of the human lobule.

The sculpturing of the outer surface of the pinna has now progressed to a stage when the organ presents most of its adult features. The helix is broad and ceases at the upper angle. The tragus is relatively small, but sharply defined. The antitragus is prominent, and very well marked off from the surrounding parts. The antihelix is a low fold with two crura. The fossa triangularis, scaphoid fossa and cymba, previously represented only by sulci, are now expanded into fossae.

The cranial aspect of the pinna is hairless save for a few hairs near its root; but the lateral aspect is uniformly covered with hairs similar to those on the rest of the head. The direction of these is indicated in fig. 3c. It will be noted that the hairs on the tragus proceed

upwards, as also those on the commencement of the helix. On the upper part of the helix they trend towards the upper angle. Below this angle the hairs on the flap-like part of the organ have a generally backward trend, but with a slight tendency to point upwards. Nearer the lobule, and on the surface of the lobule and antitragus, the direction is caudally and slightly downwards. On the antihelix and its neighbourhood, the hairs are directed upwards.

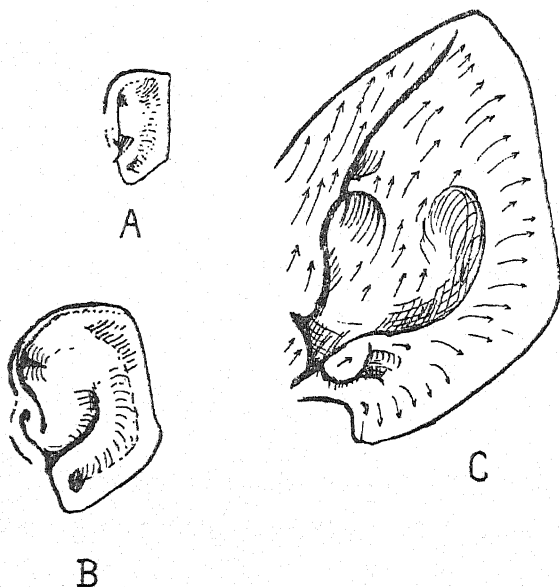


Fig. 3. Outline of the external ear of a series of foetuses of *Semnopithecus priam thersites* to show hair tracts ×

(a) 54 mm., (b) 75 mm., (c) 120 mm.

### Limbs

The limbs occupy the usual foetal position in reference to the trunk. Pigment is present in the skin on the extensor surfaces and is more concentrated on the upper than the lower limbs, and in both limbs is much more heavily developed on the dorsum of the distal segment than elsewhere. On the flexor surfaces, pigment is absent save for some deep staining on the bulbs of the fingers and some paler colour on the corresponding parts of the toes. The nails are pigmented and have advanced in development beyond the last stage described. It is now possible to distinguish clearly between the nail proper and the subungual

fold (hyponychium). On the fingers, the nails extend beyond the edge of the fold, but on the toes the two are flush. The eponychium is also clearly defined, and darkly pigmented.

The digital formula is now  $III > IV > II > V > I$ . on both hand and foot; this being the stabilized adult condition. The palmar aspect of the hand and foot are now marked by flexure lines, as well as by papillary ridges, in addition to those previously present on the fingers and toes. The plan of these is best explained by the aid of the diagram in fig. 4, where the hand and foot are compared with those of earlier embryos in the series.

I find absolutely no trace in two foetuses of this stage, nor in any other stage, of the carpal pad and vibrissae mentioned by Schultz in his youngest *Colobus* foetus.

#### *Trunk and tail*

The shoulders continue to become more prominent. The axillae are better marked, but the anterior and posterior axillary folds are not yet marked with certainty. The shape of the chest and abdomen is similar to that of the preceding stage. The trunk is widest at the upper part of the abdomen, opposite to the liver. This organ is still large, but does not extend so far over to the left as before. The stomach has now attained the characteristic sacculated form which is peculiar to the Colobidae. Mammary development does not seem to have progressed beyond the stage seen in the last specimen, but the nipples are relatively further apart. The perineal region is comparatively plain. The ischial callosities are now evident as extensive hairless territories overlying the tubera. They are not yet specially keratinized, and are pinkish in colour. They have indefinite margins of which the outline is oval, the long axis being disposed almost vertically dorso-ventral, but with the ventral ends slightly nearer to one another than the dorsal. The triangular interval so formed between them is occupied by the vulva, perineal body, and anus. The vulva is very small, and is situated opposite the middle of the interval between the callosities—not in the usual position nearer to the pubis, which region is covered by smooth, almost hairless skin, passing from one thigh to the other with no other interruption than a median sulcus. The vulva is a slit-like structure 2.5 mm. dorso-ventrally, guarded by thin fold-like lips. Half of the cleft is occupied by the short, but thick, clitoris. This now has a distinct glans, cleft on its caudal surface, the cleft leading down to the urethral orifice, which is situated at its base, within the vulvar lips. The vaginal orifice occupies the rest of the slit. The dorsal commissure

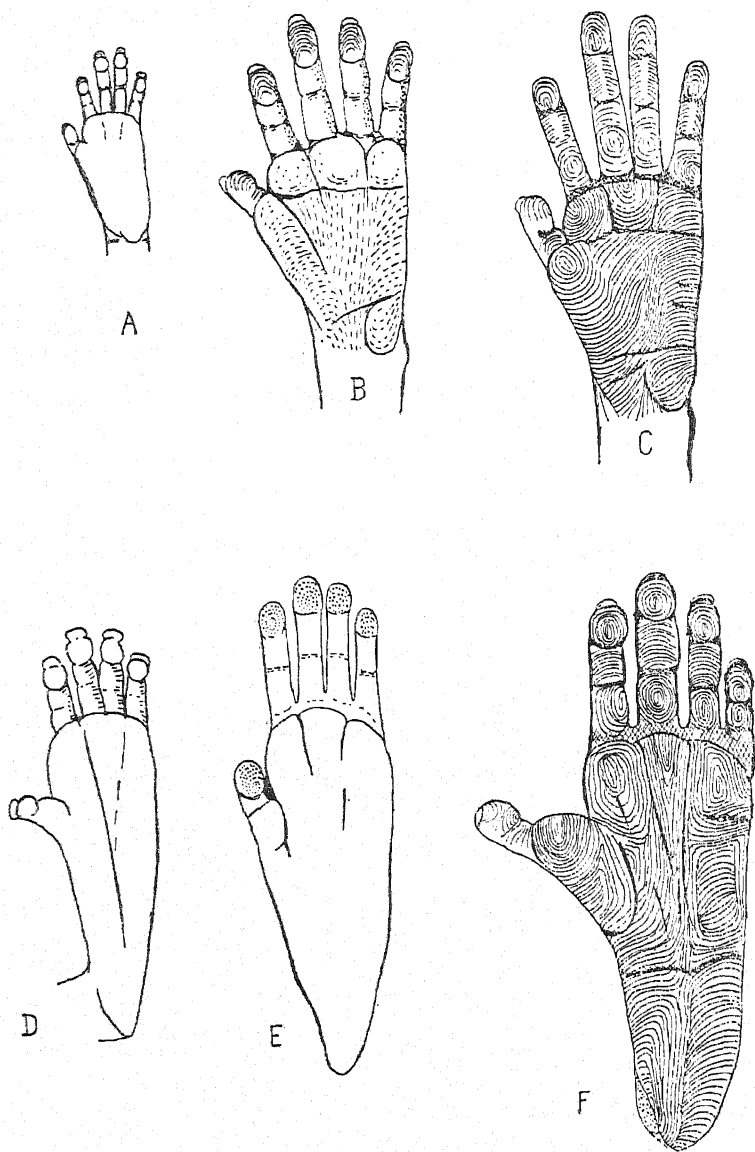


Fig. 4. Diagrams of the hands and feet of a series of embryos of *Semnopithecus priam thesites* to show the stages of development of the flexure lines and pads and the papillary ridges.

(a) Hand of 54 mm. embryo  $\times 3$   
 (b) Same of 75 mm. embryo  $\times 3$   
 (c) Same of 120 mm. foetus  $\times 2$

(d) Foot of 54 mm. embryo  $\times 6$   
 (e) Same of 75 mm. embryo  $\times 3$   
 (f) Same of 120 mm. foetus  $\times 2$

of the vulvar labia is a sharp one, and is situated 4 mm. ventral to the anal margin. The intervening tract of skin is slightly pigmented, and covered with short whitish hairs whose direction is towards the vulva.

The anus is more circular in outline than in previous stages. Its margin is puckered, and the whole is depressed somewhat below the level of the surrounding skin. Between it and the root of the tail is a median dimple. The anal canal is patent. The tail is smooth, cylindrical and gradually tapering towards its tip. The tip is rounded off, and no longer presents any terminal appendage. It is covered with hairs throughout. These are longer on the distal half, and at the tip project a little beyond the end of the tail.

*A second foetus of 120 mm. CR. length*

A second foetus (no. P.E. 25) of the same size and state of development as the preceding, was received during the writing up of the above. Its measurements are included in table II. The sex was female, the organs being similar to those of the preceding specimen. A few minor differences were noted. The chief of these were (i) the frontal radiation was situated nearer to the glabella (8 mm.) than in the other specimen, and (ii) the external ear was more rounded in outline and the helix less rolled over. The hair tracts were identical, with the exception that, in the frontal radiation, the hairs between the radiation centre and the brow fringe were arranged with a median parting. This atypical arrangement of the hairs on the sinciput was not observed in any of the other six fetuses in which the hair pattern could be made out. It is regarded, therefore, as an individual variation. The hairs in the crest formation were arranged as in the other specimens.

**Stage VIII. The foetus of 135 mm. (Plate XI, fig. 1)**

A foetus (no. P.E. 19) of 135 mm. sitting height, was procured in May 1935 at the same time as the previous stage at Kekirawa, N. C. P. There is comparatively little change in the stage just described, the most notable being the increased pilosity and greater concentration of pigment in the skin of many regions. These facts give further indication of the specific identity of the foetus. In general state of development, the foetus corresponds to a human foetus of the seventh month. This statement is confirmed by the fact that the eyelids have just reopened. In size it coincides with the second of Schultz's *Colobus* fetuses, but the latter was estimated as only equal in development to a human foetus of twenty-three weeks.



*General form and proportions* (Plate XI, fig. 1)

The slender leaf-monkey form still prevails in this specimen, but the body is generally sturdier than in the last stage, due chiefly to the continued broadening of the chest, as indicated, for instance, by the further separation of the nipples. The broadening is also to some extent due to the increased development of the muscles of the shoulder girdle. This is evidenced by the formation of axillary folds, which were not seen in earlier stages. The relative distances between the suprasternale, thelion, umbilicus and symphysis have changed less than had occurred between the last stage and its predecessor. The limbs have steadily continued in their growth and muscular development.

The head is of peculiar and characteristic shape, quite different from that of the adult of any monkey, except the anomalous Squirrel-Monkeys (*Saimiri*) of South America. The cranium is low and narrow, but very elongated from before backwards. The occiput, therefore, projects backwards and a deep nuchal depression is so produced. This type of head-form seems to be characteristic of the leaf-monkeys, as far as Old World species are concerned. The disproportion between the size of the head and the rest of the body has now almost disappeared, but the cranium is still large compared with the face.

The skin is now more wrinkled, though not so much as in the seven months human foetus.

*Pilous system*

The hair is more fully erupted than in the previous foetus. The advance is greater, however, on the head, shoulders, upper limbs, and upper back, than on the lower back or lower limbs. It would further appear that there is a greater density of hair, for more hairs occur on a given area of skin. In view of the fact that the total hairy surface is considerably greater than in the last stage, there must have been a great increase in the number of hairs developed in the intervening period. The direction of the hairs is the same as in the previous stage. The arrangement on the crown is interesting, for the crest is now slightly upstanding, and its exact formation in reference to the hair-tracts can be made out, whereas in the adult it cannot. The brow-hairs project straight forwards and already differ from those of the related genus *Kasi*, in which, at this stage the brow-hairs are quite as long, but directed upwards.

All the hairs are pigmented and thus appear black in colour. This black colouration of the first crop of hair (lanugo) seems to be a generic character for the Entelloid group of leaf-monkeys (*Semnopithecus*),

but has thus far only been observed with certainty in true *entellus* and in one of the Malabar forms. The blackness increases with advance in foetal development, and is still present in the new-born young. It is, however, speedily changed for a very much lighter coat of coarser hair during the first few months of postnatal existence. In the present species the contrast between the black lanugo hair and the second crop is very marked, this latter being almost white, but with a trace of pigment in certain areas giving the effect of a very light silvery grey. This light colour persists thereafter until puberty, after which some further darkening occurs, especially in the insular subspecies (*thersites*).

### Pigmentation

Skin pigmentation is present in the same areas as in the preceding specimen, but is markedly denser. The face is still without pigment. Pigment is also absent from the ear, palms of the hands, soles of the feet, callosities, and ventral aspect of the tail near its root. The eponychium is less darkly coloured than in the previous specimen; but the nails show some dusky colour near their roots, being for the remainder yellowish. The genitalia are without pigment.

### Face

In the face, there has been a further development of the folds and sulci. The sulci, between the upper and lower eyelids and surrounding orbital skin, are still in the same condition as in earlier foetuses. These appear to correspond with superior and inferior orbito-palpebral sulci of Luce (1936), but they may represent his sulci anonymae. Connecting these sulci with their fellows across the bridge of the nose is a complete sulcus interpallebralis as in de Beaux's *Colobus*, but the connection takes place above the level of the inner canthi. A short, incomplete accessory sulcus is connected to the inner canthus of the right side, but this fades out over the nasal bridge. There is a deep, sharply defined sulcus extending from the lower part of the side of the nose obliquely downwards and laterally on to the side of the head. This is the representative of the sulcus oculo-malaris of Luce. It is more horizontal in position than in the human face, and diverges from the alar sulcus of the nose much more than in Man. The alar sulcus is now well developed as a semilunar sulcus forming a limit to the nasal pad on each side. There is a slight sulcus angularis at the extremity of the oral fissure on each side.

A word may be added on the hair of the face. This is much more advanced than in the previous stage and the direction of the streams is

of some importance. The frontal radiation is situated 16 mm. behind the glabella. As the hairs are longer, the radiation can now be seen to be in reality a whorl, and not a simple radiation. The arrangement is almost identical with that described for the "bonnet" of the new-born *Macaca sinica* by the present author (1932). The whorl has a clockwise direction. The brow hairs project directly forwards as before, and form a double curve, being concave downwards over the orbits and convex over the nasal bridge. From the glabella they descend somewhat on the bridge of the nose, to become continuous with some very short, fine hairs forming a median tract thereon. The direction of this tract is downwards.

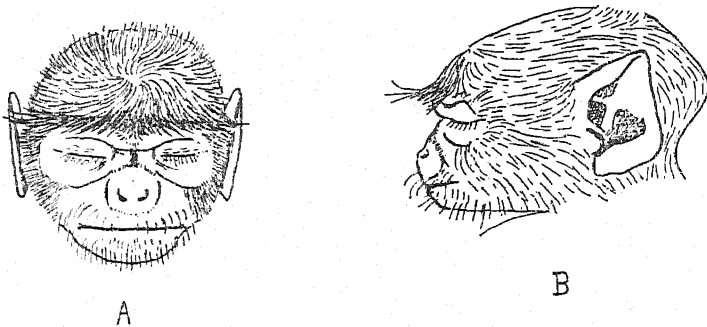


Fig. 5. Drawing of the facial features of the 135 mm. foetus of *Semnopithecus priam thersites*, to show especially the sulci and the direction of the hair tracts. Compare with fig. 1.

Longish, fine hairs now appear on the malar region. These have a downward and backward direction. The nasal pad and the septum are clothed with very fine, short, unpigmented lanugo, the hairs of which all trend downwards. Between the oculo-malar sulcus and the nose, and also on the lips there are long, wiry, pigmented hairs of the sinus-hair type. These too point downwards, except laterally where they have a backward tendency superadded. Eyelashes resemble those of the previous foetus.

The eyelids are closed, but, as already pointed out, they are no longer fused together at their margins. The interocular region is still relatively broad, but is now convex from side to side, thus forming the bridge of the nose. The nasal pad is less prominent than hitherto, but the area is now more sharply marked off by the alar sulci than in the last foetus. The upper lip is narrow, and slightly convex from above down. The lower lip is flatter. Both lips have well defined margins,

and are now easily separable from the gum. The latter shows no tendency to tooth eruption. The tip of the tongue protrudes into the vestibulum oris. The chin is poorly developed.

The ear is remarkable for its relatively large size. It has made no advance on the last stage described. Its hairs are somewhat longer and more deeply pigmented.

### *Limbs*

Little change appears to have taken place in the limbs beyond increased hairiness and pigmentation. The amount of growth in length can be judged from the tables of measurements, and indices. Muscular development has increased, giving more roundness to the parts; but subcutaneous tissues are still relatively scanty.

The hands and feet are much the same as in the 120 mm. stage. The outlines of the palmar and plantar pads, however, are now largely effaced, but their sites are marked by the arrangement of the papillary ridges of the epidermis, which are complicated, and extremely well marked. Their arrangement is shown in Fig. 4c, f.

The nails are of similar shape to those of the earlier foetus described above. They are convex, both from side to side and from above downwards. Together with the subungual fold, they project beyond the surface of the fingers and toes; but on the fingers the fold does not project as far as the nail, whose free border appears bent over it. On the toes the nail border only reaches as far as the free extremity of the fold.

### *Trunk and tail*

The general form has already been discussed. The formation of the axillary folds is important; as is also the further separation of the nipples. The mammary areola can be distinguished around the nipple, whilst on the latter the openings of the ducts can be made out. Below the nipples the caudal border of the pectoralis major muscle makes a prominent fold passing outwards towards the axilla, and crossing the anterior axillary fold. The abdominal wall is uniformly rounded. The umbilical cord is relatively thicker than in the last stage. The sex of this specimen is male; and the penis is situated well back between the thighs. This organ is small for a monkey, in great contrast to a foetal macaque, and is completely ensheathed in a prepuce. The latter has a small, puckered orifice, from the ventral margin of which a well marked median raphé extends along the under surface of the penis on to the perineum, and is traceable as far dorsally as the ventral

border of the conjoined callosities. The callosities are now more obliquely disposed, due probably to a separation of the ischial tuberosities. Their lateral and dorsal margins are more raised than the ventral. Medially they appear to fuse as there is no hairy tract between them. The anus lies in a transverse depression between the raised dorsal margin of the callosities and the root of the tail.

The tail is similar to that of the 120 mm. stage, but more hairy, especially towards its distal end.

#### *Additional material*

Three more foetuses of the same stage of development as the preceding have recently been received from Mr. W. A. L. Schofield. They differ slightly in their measurements from one another, as well as from the specimen just described, indicating there are individual variations in size in these later stages of intra-uterine life. Thus the crown-rump measurements in the foetal posture of the three were 130, 130 and 145 mm., respectively; but in the extended position they measured 160, 165 and 180 mm. The first two, therefore, were slightly less in size than the above described specimen, whilst the last was somewhat larger, reaching in its maximum measurement the same size as the full-term example described hereafter, though in development it was definitely on a par with the present series rather than with the full-term specimen.

The first of these (no. P.E. 26) is a female. It is slightly less pigmented than the preceding. The hair is of similar development, but rather thinner on the cheeks and sinciput than in the male described above. The beard-like growth of hairs on the lower lip and chin is rather longer. The frontal radiation is 16 mm. behind the glabella. The eyelids have just opened. There are several incomplete interpalpebral sulci. The ears are a little smaller, but more hirsute than in the previous example. In the genital area there are some important differences. The callosities are smaller, more vertical in position and distinctly separate. The pudendal region lies between them in their dorsal half, and is depressed. The mons pubis is continued backwards (*i.e.*, dorsally) between the ventral halves of the two callosities as a swollen fleshy body, covered superficially by short white hairs pointing dorsally. This object contains the clitoris, which is itself invisible, and is separated from the callosities on each side by a deep sulcus; but there are no signs of labia. The vaginal orifice is deeply placed beyond the dorsal extremity of this median swelling, and is inconspicuous, being guarded by swollen skin dorsally and by a

globular swelling on either side. The dorsal swelling is continuous with the perineal body, and, like it, is covered with white hairs directed towards the vulva.

The second specimen (no. P.E. 27) is also a female, and is very similar to P.E. 26. It is a very dark example, the dark colour being due to increased body pigment, as well as to a greater pilosity. Its frontal radiation lies 17 mm. behind the glabella, and is similar to that of the male described above. The face is like that of the preceding female, and the ear, as in that specimen, is smaller and hairier than in the male. The eyelids and neighbouring parts agree with the other specimens of this stage. There are two complete interpalpebral sulci, whilst the other facial sulci are similar to those of the male. The umbilical cord in this example was 148 mm. long. The genitalia and neighbouring parts were exactly like those in the female just mentioned, and are thus in advance developmentally of the female of 120 mm. crown-rump length. Meconium was being extruded from the anus in this specimen.

The third of these additional specimens (no. P.E. 28) is another male, very similar in appearance to P.E. 26, but slightly larger, and resembling the male no. P.E. 19 in having the ears larger and less hairy. The frontal radiation is 22 mm. behind the glabella. The other parts of the pilous system agree with those of the previous specimens, except that there is a whorl on the flank, just anterior to the groin. This is formed at the meeting place of the caudally running tract on the dorsal surface of the body, with the cephalically directed tract from the groin. The callosities are fused in the mid-line and the genitalia are as in the male last described. Meconium was present on the anal margin, as in the female specimen last mentioned.

### Stage IX. The foetus of 168 mm. (Plate XII)

One foetus of this stage was recovered at Kekirawa in May 1935. It is a male, and is regarded as having reached full term because it has much the same size and is in the same state of development as the hybrid foetus (*S. pallipes* ♂ × *Kasi vetulus nestor* ♀) recently described by me (1936) and which was known to have reached full term. The state of development, as far as external features are concerned, is, moreover, much the same as that of the human foetus at the end of intra-uterine life. The only significant exception is, that in the monkey, there is no shedding of lanugo such as usually begins before birth in the human foetus. Judging from the hybrid example mentioned above, the monkey is in advance of the human individual

as regards the ossification of its skeleton at this period. Further detailed studies on the skeletal system will, it is hoped, form the subject of a further contribution on the present series of monkeys.

In addition to the obvious increase in size, the present foetus has a more rounded form, due to increased padding by subcutaneous tissues. Its weight is now 500 gms. It has increased in pilosity, but pigmentation has not increased to any appreciable extent. The centre of the frontal radiation is situated 15 mm. behind the glabella. The radiation still shows evidences of its whorl-like origin. The whorl on the flank mentioned in connection with the specimen no. P.E. 28 is also noticeable in this full-term example. Otherwise the hair tracts are the same as in the previously described specimens. The crest on the vertex is now more evident, due to the increased length of the individual hairs. The crest, in other words, is becoming a manifest object, and not a mere surface arrangement of the hairs.

#### Face

The facial appearance is changing somewhat as a result of (a) the further elaboration of sulci, and (b) the growth of the surrounding hair, more especially the beard. These points are illustrated in figure 6.

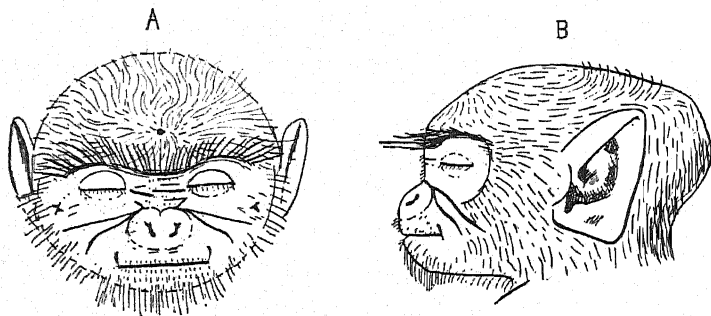


Fig. 6. Facial characters in the full-term foetus of *Semnopithecus priam thersites*  $\times \frac{2}{3}$

The brow hairs do not seem to have advanced in growth since the 135 mm. stage. Beneath them in the mid-line is the raised nasal bridge. This is surmounted by several more or less complete interpalpebral sulci. The lowest of these are oblique, short, and run medially

into the convex border of the alar sulcus of the nose. From the angle so formed a couple of very deep sulci sweep outwards and downwards. The upper of these is the oculomalar sulcus. The lower is the nasolabial sulcus, and is a new formation. Beneath this again is the angular sulcus, now much more definite than in the last stage. The eyelids and associated structures are the same as in the last stage.

The black hairs on the cheeks are now mixed with a crop of white hairs, all having the same downwards direction. On the chin, all the hairs are white and form a definite beard. The darker, wiry hairs originally present on the lips and chin seem now to have disappeared.

The ears are little advanced beyond those seen in the fetuses already described. The lower part of the pinna opposite to the concha is, however, rather more expanded, and the lobule rather more distinct.

### *Limbs*

The limbs show no advance, except in size, on the stages already outlined. The nails are in the same condition on hands and feet as in the 135 mm. stage. They are all convex both from side to side and proximo-distally, but the one on the hallux is flatter than any of the others. There are some white hairs growing on the buttocks, amongst the black ones, thus giving rise early to the characteristically pale area of the postnatal stages of this species.

### *Trunk and tail*

The trunk in the full-term foetus has an elongated barrel-like form, nicely rounded, but with its skin still somewhat coarsely wrinkled transversely. The chest is small compared to the abdomen, but is relatively broader than in earlier stages. The nipples are prominent, surrounded by a sulcus, and around this by a relatively naked areola with finely papillated skin. The umbilicus is still relatively low down. The attachment of the cord covers an area 8 mm. in diameter. The cord itself is 182 mm. long and coiled spirally in the usual fashion.

The genitalia are similar to those of the male of the preceding stage, apart from a slight increase in size. The callosities are also similar to those of the earlier males, being united in the mid-line and disposed differently from those of the female.

The tail shows a proportionate increase in length on the preceding stage, and is also thicker and more hairy. The hair at the tip projects 10 mm. beyond the tail, but presents no indication of the spiral whorl characteristic of the grown animal of this species.



## DISCUSSION

In summing up the main points brought out by a study of the above described series of embryos and fetuses of the Grey Langur, it is useful in the first place to consider the features in which they differ or resemble the corresponding stages in human development.

The monkeys differ from Man very early in showing, as a rule, a double placenta instead of a single one. This seems to be quite usual for Catarrhine monkeys, and in this respect the latter differ also from the Platyrrhines and the anthropoid apes. It has even been suggested, with some reason (Keith, 1900), that this type of placentation has been derived from the zonary type. It must be pointed out that the bi-partite type of placenta is not absolutely constant even in one genus of monkeys. In the hybrid leaf-monkey described by myself, the placenta was single as in Man, and I have seen the same thing in specimens of *Kasi*. On the contrary, I find that a bi-partite placenta, exactly like that of the Catarrhines, is very common among the local human population in Ceylon.

*Semnopithecus* further differs from Man in the number of mesodermal somites. In Man, according to Keith, there are three occipital and thirty-five body pairs of somites. In the monkey I found forty-three somites altogether. The next important feature is in the length of the tail. In the monkey this is longer than in the human embryo from the start. Moreover, whereas, in the human embryo, the tail disappears by the tenth week, in the monkey, it persists and grows in length throughout pregnancy. In general form of the trunk the monkey is early marked off from the human condition (and presumably also from the apes) by its more elongated, slender, form. This becomes more marked at succeeding stages from the 15 mm. stage. The appearance of the Anlagen of sinus hairs on the upper lip of the 15 mm. monkey embryo is a significant feature in which it differs from Man. The form of the foot from the 24.5 mm. stage onwards also marks off the monkey from the human being. The rudimentary state of the thumb at the same stage distinguishes the series from Man, and also from other Catarrhines, except those of its own family (Colobidae). At the same time, the excessive elongation of the remaining digits on the hand and of the corresponding digits on the foot is likewise a character indicative of the Colobid family of monkeys. The degree of lagging behind in development of the foot over the hand, and of the toe nails over the finger nails, is not so marked in the monkey series as in human ontogeny. At some stages (e.g., 54 mm.) the difference is negligible, but increases very slightly as development proceeds up to full term.

From the 54 mm. stage onwards, there is a general tendency for the exhibition of greater advance in development, with reference to size, compared with a corresponding series of human embryos and fetuses. This tendency is correlated with the difference in bodily size of the adults of the species concerned. The difference would apply equally to the apes, as to the human species when compared with the monkey.

Differences between the monkey series and a human series become increasingly obvious in the later stages of pregnancy. Foremost among these are the general form of the external ear (except for the lobule), the hair development and its direction, and the prominence of the ischial tuberosities, followed later by the development thereon (at some period between the 75 mm. and 120 mm. stages) of the naked callosities.

Resemblances between the development of the monkey and corresponding human stages are briefly as follows:—

- (i) the peculiar spiral twist on the long axis of the 9 mm. embryo.
- (ii) the form of the neural tube and cerebral vesicles.
- (iii) the mode of formation of the face and branchial arches and the mode of disappearance of the latter.
- (iv) the slight advance in development of the fore-limb over the hind-limb, except in certain stages.
- (v) the presence of an umbilical hernia at one period.
- (vi) the disproportionately large head.
- (vii) the disproportionately large cranium to the face.
- (viii) the projection of the upper jaw beyond the lower at about 1/3 term embryos.
- (ix) the presence of a lobule on the pinna.

The last character seems to be confined to this family of monkeys and to Man, for it is not found in the Apes, nor in Macaques and their relatives. It has, in fact, usually been regarded as a peculiarly human characteristic.

In the second place it is interesting to discover at what period of intra-uterine development the various ordinal, familial, generic and specific characters appear. Characters indicative of the Primate order are apparent in the 24.5 mm. embryo, *i.e.*, at a corresponding stage to that of a human embryo which first shows its Primate features. At this stage the head is too large proportionately for the embryo to be assigned to any other order than Primate. At the same time there is a gross disproportion between the cranial size and the size of the facial part of the head. At this stage also the extremities already show their characteristic Primate form.

The only available character in pre-natal life, for the discrimination between a Catarrhine and a Platyrrhine monkey, is the form of the external nose. The anatomy of the tympanic region and of the dental system cannot be made of use. The tympanic region retains its primitive (*i.e.*, Platyrrhine) condition till after birth even in Man. The dental characters might be of use if the jaws were serially sectioned in order to discover which tooth rudiments were present. As no Platyrrhine embryos are available to me and Schultz's *Alouatta* is too advanced for comparison, I have, therefore, to assume that the nasal structures of my series have already attained Catarrhine form before the 54 mm. stage of this series. At this stage the embryo shows characters which enable it to be referred to a particular group of the Catarrhines, namely, the Colobidae. The proportions of the length of the limbs to the trunk-height indicate the familial status; whilst this is still more evident in the great proportionate length of the hands and feet, and of the fingers and toes. By the 75 mm. stage, the external nose differs considerably in form from that of a Macaque of the same size (see p. 227), whilst the Macaque further differs in its more advanced pilous system. In the Macaque at 75 mm. it is just possible to make out the hair trends on the head, and thus to be able to state the exact species of Macaque concerned. Thus, in the local Macaque (*Macaca sinica*), it is possible at this early stage to make out the whorl of hair on the pre-auricular region, which distinguishes it from its close ally *M. radiata*.

Presbytine (*i.e.*, sub-familial) features are not indicated in the present series of embryos before the 75 mm. stage. At this period of development the thumb is already rudimentary when compared with the other digits on the hand, but is nevertheless sufficiently large to distinguish it from that of a Colobine monkey of similar size.

It is interesting to note, however, that the complicated stomach and grossly modified liver, which characterize the adults of all the Colobid monkeys (both Presbytine and Colobine), do not become manifest until the 120 mm. stage. The situation of the genitalia close to the anus, especially in the female, is present in the 75 mm. embryo. According to Pocock (1925) this is characteristic of the family Colobidae, but more especially of the Asiatic forms.

Generic characters are present in the 120 mm. embryo. Here the frontal hair radiation distinguishing *Semnopithecus* from other leaf monkeys is evident. Further distinguishing characters are the form and direction taken by the stiff brow hairs, and the black colour of the lanugo coat. Hair development is in advance of that seen in

*Colobus* at the same stage (cf. Schultz, 1924), although, as pointed out above, it is considerably behind that of the Macaques.

Specific features are indicated at the same time as the generic characters, for, in the 120 mm. stage, the arrangement of hair on the vertex, which precedes the formation of a crest in that region, is already evident. Although I have not seen the foetus of the typical species of *Semnopithecus* (*S. entellus* of Bengal), it is hardly conceivable that the hair arrangement in that species would be identical with that shown by the 120 mm. foetus of the present series. The same applies to all the other crestless forms of *Semnopithecus*. The hair arrangement, therefore, is probably a fundamental one, and irrespective of whether the crest becomes a manifest object or not, this arrangement is evidently of specific importance at least. The characteristic white buttocks of the species (*S. priam*) do not become evident till full term.

Finally, allusion may be made to the appearance of the sexual features. The sex organs in their primitive "sexless" condition are present in the 15 mm. stage. It is still not possible to distinguish the sex by external examination in the 54 mm. stage, despite the advance in the development of the organs. Sex is first distinguishable externally in the 75 mm. embryo. In the male the penis remains small throughout pre-natal life, and is thus in great contrast to the embryo Macaque. The vulva, on the other hand, though small, evolves into a rather specialized form, as indicated in the 135 mm. stage (see p. 242). Of the secondary sexual characters, it may be noted that the callosities, which do not appear till the 120 mm. stage, differ in the two sexes, being confluent in the male and separate in the female, from their first appearance. Nipples are first seen in the 54 mm. stage, but, without making sections, it is impossible to state whether mammary gland tissue is present at so early a period. From a consideration of human development this is very unlikely to be the case. A tertiary sexual difference is to be noted in the external ear, which, in the present series, appears to be smaller and hairier in the female than in the male.

#### SUMMARY AND CONCLUSIONS

1. Thirteen embryos and foetuses, representative of nine different stages of intra-uterine development of the Grey Langur (*Semnopithecus priam thersites*) have been described in detail, measured, and compared with corresponding stages in human development.

2. Points of difference, between, and of likeness to, the human embryo, at various stages have been indicated.

3. Points of difference from known stages in the pre-natal life of macaques have also been alluded to.

4. The stages at which ordinal, familial, generic and specific characters make their appearance have been mentioned.

5. The importance of the crest, or the hair arrangement to which it owes its presence, as a specific character, has been stressed.

#### ACKNOWLEDGEMENTS

I wish to tender my thanks to Mr. D. R. R. Burt, of University College, Colombo, for his assistance in photographing some of the embryos in the series described. I have again to thank Dr. A. J. E. Cave of the Royal College of Surgeons, London, for his generous assistance in the matter of literature. I must also acknowledge my indebtedness to Mr. W. A. L. Schofield for his generous gift of certain of the specimens, together with notes on the localities and times at which they were collected. I am also indebted to the Research Fund of the Ceylon Medical College, a grant from which was utilized in purchasing material and apparatus used in the above study.

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EXPLANATION OF PLATES

Plate VIII

*Fig. 1.* Photograph of 9 mm. embryo of *Semnopithecus*

*Fig. 2.* Same of 15 mm. embryo

Plate IX

*Fig. 1.* Photograph of 24.5 mm. embryo of *Semnopithecus*

*Fig. 2.* Same of 54 mm. embryo

Plate X

*Fig. 1.* Photograph of 75 mm. embryo of *Semnopithecus*

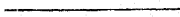
*Fig. 2.* Same of 120 mm. foetus (female)

Plate XI

Photograph of 135 mm. foetus of *Semnopithecus*

Plate XII

Photograph of full term foetus (male) of *Semnopithecus* with placenta





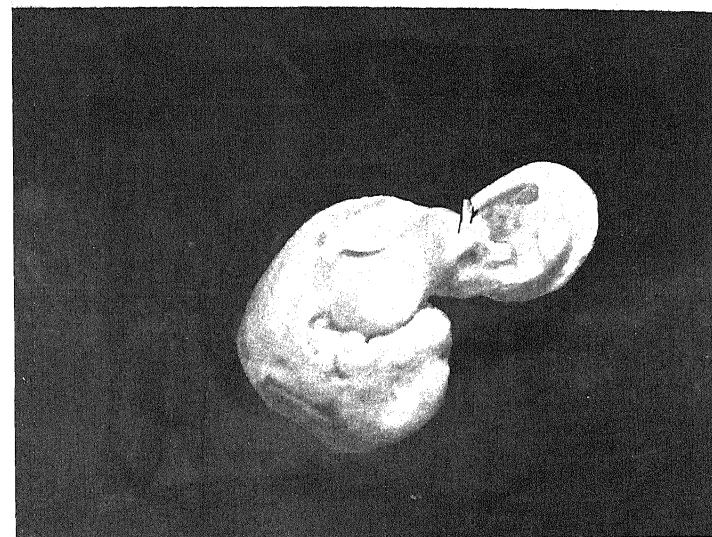


Fig. 1.

Embryos of *Semnopithecus*

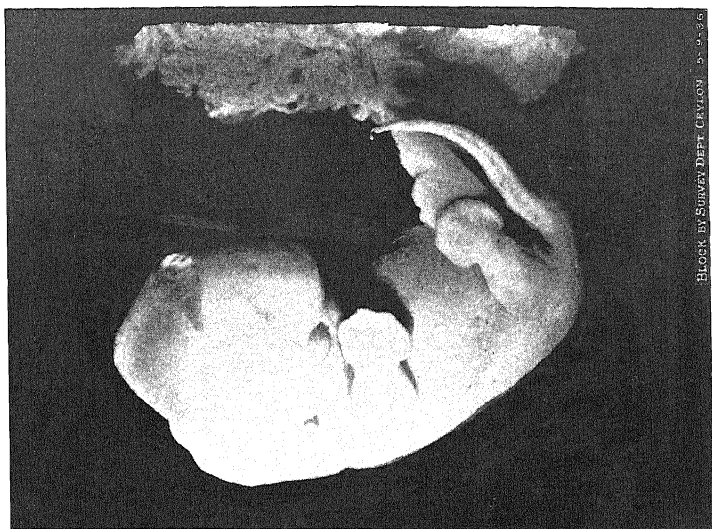


Fig. 2.





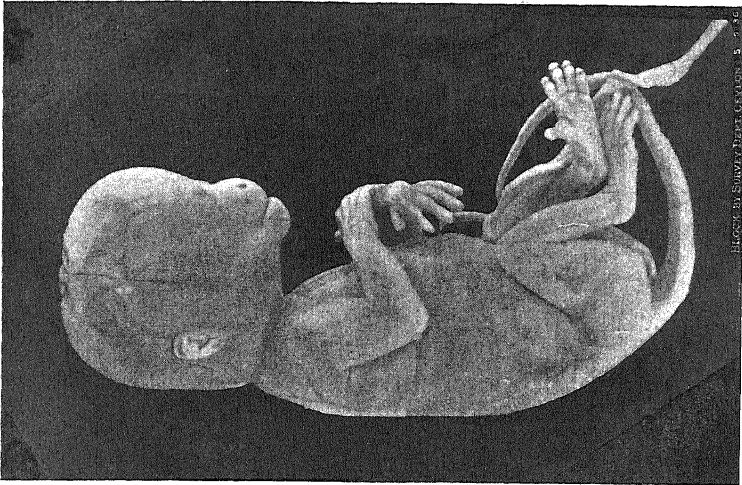


Fig. 2.

Embryos of *Sennopithecus*



Fig. 1.



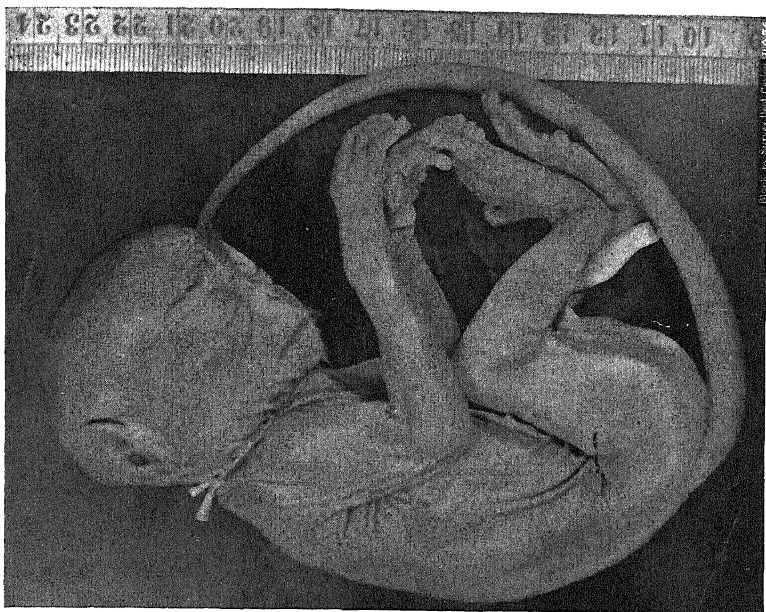


Fig. 2.

Embryo and Foetus of *Semnopithecus*

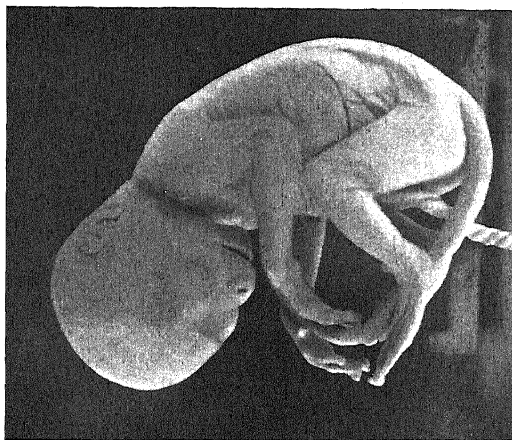
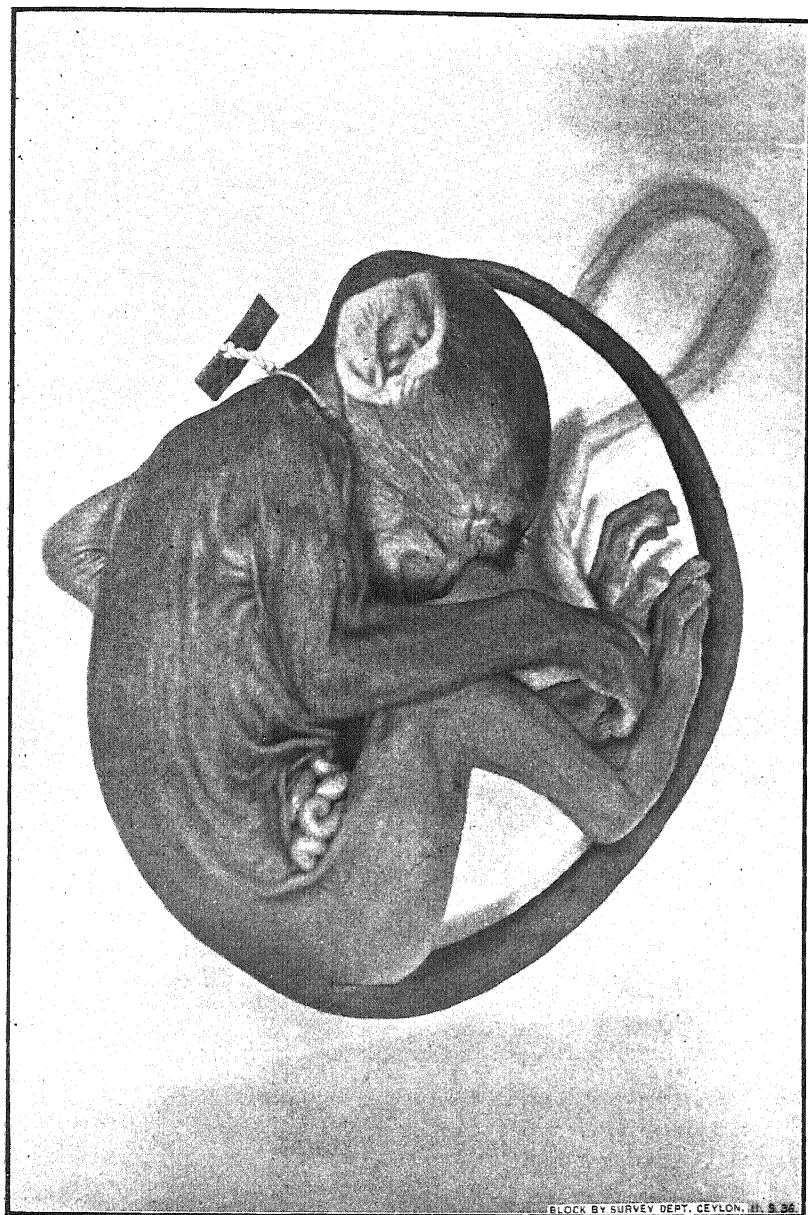


Fig. 1.





Foetus of *Semnopithecus*





Full term foetus of *Semnopithecus*





## NOTES

### 1. The Nest-guarding habit of the Estuarine Crocodile of Ceylon (Plate XIII)

A brief description of the nest guarding habit of *Crocodylus porosus* (Schneider), was published in an account on the reproduction of this species [*C. J. Sc.* (B), XIX, p. 255], but further opportunities of examining other nests have revealed several unrecorded features.

A nest, visited at Maha Bellana (Western Province) on July 26, 1936, at 11 A.M., was about 90 metres away from the main body of water and possessed two guard wallows. In one of these, which was about half the length of the animal, the guarding mother lay with belly and hind limbs submerged. The tail sloped distally upward on to the nest suggesting that the animal had basked there before descending into the wallow. The crocodile was emaciated and its senses so dulled that it was possible to approach to within four metres under cover of the *Lagenandra toxicaria* growth and photograph the animal without disturbing it (Plate XIII, fig. 1). A few minutes later a bullet in its ear killed it instantaneously, the only visible sign of death being the closure of its eyes. After the eggs in the nest were exposed, the undisturbed animal was again photographed lying in almost the identical position it had assumed when on guard (Plate XIII, fig. 2).

Its dimensions were as follows: lateral head length 41 cm.; snout tip to cloaca 126 cm.; the tail which was mutilated was only 115 cm. The algal coating which discolored the teeth apparently denoted their lack of use, an opinion supported by the animal's feeble condition and its empty stomach, which only contained the usual gastroliths weighing 95 gm.

The nest contained twenty-five eggs. Four of these were putrid and as their calcareous shells were much corroded externally it is possible that they had come in contact with an excessively acid patch of vegetable mould. In view of the advanced putrefaction of the eggs and the emaciated condition of the crocodile it was surprising to note

that the nest was not very old, for the eggs contained comparatively young embryos which were no more than a quarter mature. The length of one embryo was 95 mm.; the eyelids were incompletely developed; pigmentation was incipient.

Half an hour later another nest was discovered about 80 metres from the first. It was built at the very margin of a secluded lakelet, about one and a half metres deep, and located in the midst of the *Lagenandra toxicaria* at a distance of about 170 metres from the main river. Although the nest was nearly in water, it possessed two guard wallows and resembled the first in containing twenty-five eggs. A shallow groove on the summit of the nest and down each side denoted that the crocodile frequently ascended it to bask. The animal was not to be seen and the lack of turbidity in the neighbouring water suggested that it had left some considerable time before our arrival. The eggs were removed, but the crocodile did not return to defend its nest although the guide, who returned to the scene directly the party left the lakelet, affirmed that the animal floated for a few seconds about 100 metres away, but submerged upon seeing him.

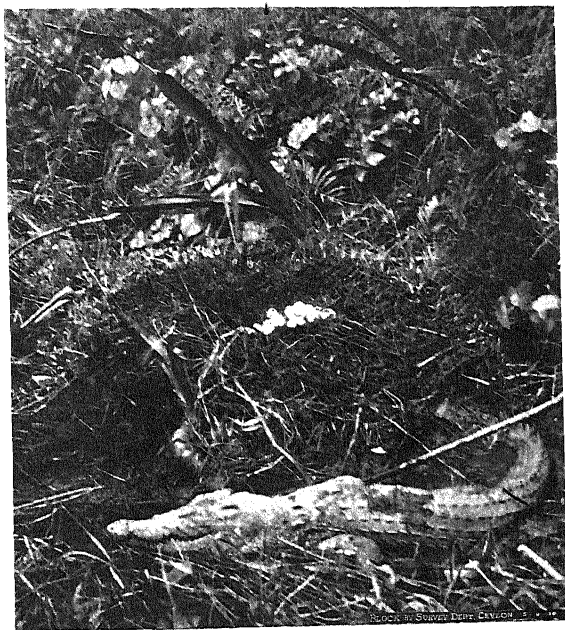
As embryos of this nest were 160 mm. long it was evident that the eggs had been laid some weeks prior to those of the first nest, although the number of eggs and size of the nests suggested that the crocodiles were of about the same age and size.

During the past three years, four nests of *Crocodylus porosus* have been observed. In two the female parents, shot on guard, possessed empty stomachs, while the absence of a guardian in the other two instances might have been due, either to the animals sensing the approach of men, or to their having left the nest to forage. The latter view is not supported by the empty stomachs of the two crocodiles examined. The crocodile, if of moderate size, does not appear to be fiercely aggressive in defence of its nest and, in places where it is hunted, apparently deserts its eggs upon sensing the approach of men. The two wallows alongside a nest located almost in the water suggest that these result from the animal removing mould for nest building.

It is also evident that the crocodile spends a considerable part of its watch basking on top of the nest and it is possible that this action is of some help in incubation, either by protecting the eggs from the noon day sun, or by helping to maintain an even temperature, or by both.



1.



*Crocodylus porosus* (Schneider)



## 2. Longevity in a Macaque

Flower (P.Z.S. 1931, pp. 154 *et seq*) reported the maximum ages to which various species of monkeys were known to have lived in captivity. Among these the macaques take the highest place, as would be expected from the hardy constitution of most of them. The most hardy species, and those living to the greatest age in captivity, appear to be the Rhesus (*Macaca mulatta*), Common (*M. irus*) and Bonnet Macaques (*M. radiata*). The oldest Rhesus recorded with certainty was 24 years of age at death and lived in the Melbourne Zoo. Another kept by Col. S. M. Benson was stated to be 'probably 29 years old at death'. Zuckerman is reported as having seen some Common Macaques in the Cape Town Zoo that were known to be 27 years old, and were remarkable in having lost large patches of hair from their bodies (June 1930). In Singapore the average life of this species is given as 15 years. *M. radiata* does not usually live so long as the other two, its average span of life in Trivandrum Zoo being only 12 years and the maximum only 15 years.

It is therefore, I think, worth recording that a male Toque Macaque (*M. sinica*) that died in Colombo on 11-III-1936 lived to a greater age than any of the above. This animal was an experimental specimen in the collection of the Government Bacteriological Institute, Colombo, and had been there longer than any of the present staff could remember. He was known to be at least thirty years old and was probably five years older. Dr. L. Nicholls, Director of the above Institute informs me that this monkey was one of a series that had been used many years ago by Sir Aldo Castellani in his experimental work on yaws. This was published in 1907. (*J. Hyg.* VII, No. 4, pp. 558-559.<sup>1</sup>)

I had myself observed this animal many times and had noted him to be fat and lazy, and somewhat aged and scarred in the face. But apart from this, he did not appear unusual, until a few days before his death, when I noticed him performing athetoid movements with his hands.

A post-mortem was held with a view to finding out what senile changes were present, with a more or less preconceived idea that he had died of extreme old age. It was discovered however, that death was not due to any senile change, but to a septic meningitis of the basal

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<sup>1</sup> The following quotations from Castellani's paper refer to the monkeys used:—

'Altogether eight monkeys of the genus *Macacus* and eleven of the genus *Semnopithecus* have been inoculated with scrapings taken from the eruptive lesions of yaws patients' (p. 559).

'Monkey No. 4. 10-xi-06'. This date was the date of inoculation, thus making our specimen 30 years old at least, and, as the animals were probably full grown, they were at least three years old at the time of inoculation.

aspect of the brain in the posterior cranial fossa. There was considerable oral sepsis and pyorrhoea.

Senile changes were comparatively scarce, and there seemed no reason for the animal not living still longer had it not been for the acute infective condition. The following notes were made at the time:—

Weight 4,025 gms.; well nourished; subcutaneous tissues, omentum and mesenteries loaded with fat; appendices epiploicae numerous and large; testes atrophic; kidneys normal; liver not cirrhotic; spleen small, soft and friable; heart normal but fatty; a little atheroma in the commencement of the aorta, but none elsewhere; radial artery normal; lungs pink, but speckled with greyish areas.

The skeleton has since been prepared and the following remarks may be made thereon. Skull large and heavily built, with prominent muzzle; teeth much worn and the canines broken, three upper incisors lost; all sutures obliterated on cranium and face; apertura pyriformis asymmetrical; wall of maxillary sinus very thin; spine kyphotic and with lateral curves, especially in the lumbar region; evidence of old spondylitis in lumbar series; thorax roomy; costal cartilages not ossified; pelvis very large with much everted ischia; limb bones normal.

#### *Addendum*

Since the above was written I have come across another instance of longevity in a Macaque. This was a male Celebesian Black Macaque (*Macaca nigra* ?sub-sp.) which lived in the Trivandrum Zoo and whose skin I examined in the Trivandrum Museum. The animal was purchased on 15-VI-1907 and was then said to be full grown. He died after 26 years captivity in 1933. The skin showed considerable areas of the coat to have undergone greying, especially on the back and outer sides of the limbs. This greying was said to have commenced about four years before he died.

Flower (1931, *loc. cit.* p. 155) says that the Black Ape seldom lives more than ten years in captivity, but gives (*vide* Ridley) an instance of the Batchian race living for fourteen years in Singapore, and another (*vide* Hughes) which was still alive after eighteen years. The Trivandrum example exceeded both of these in its life span in captivity.

I am indebted to the respective curators of the Zoo and Museum in Trivandrum for their assistance and for access to the registers.

W. C. OSMAN HILL.

### 3. Supernumerary nipple in a Macaque

Hartman (1927 *J. Mammal.* VIII, 96), Coolidge (1933, id., XIV, 66) and, more recently, Zuckerman (1935, id., XVI, 229) have drawn attention to instances of supernumerary nipples in various sub-human Primates. The following instance of unilateral duplication of the nipple may be added to the list. The monkey affected is a sub-adult female *Macaca sinica*. She has reached puberty, and has menstruated several times, but has not yet been pregnant. She has an extra nipple below the normal one on the left side. The supernumerary organ is smaller than the others, but has the same form and pigmentation. This is exactly like the one reported by Zuckerman in a Rhesus monkey.

[I have since discovered in my collection of living Primates that a female Patas Monkey (*Erythrocebus patas*) has a small supernumerary nipple on the left side situated a little *above* and lateral to the normal nipple.]

W. C. OSMAN HILL.

### 4. Birds of the Resident Sportsmens' Reserve and Yala Game Sanctuary, Southern Province, Ceylon

Two visits have been paid by the writer to the Southern Sportsmens' Game Reserve and the Yala Game Sanctuary, viz., in December 1931 and in February 1936; in each case through the hospitality of Mr. and Mrs. A. C. Tutein-Nolthenius who invited me to accompany them, for the purpose of collecting insects for the Colombo Museum, on their shooting trips. As the localities mentioned are frequently visited by sportsmen, wild-life photographers, etc., it seems worth while to publish the following list in order to provide those who are interested with a skeleton on which to append their own observations. Needless to remark, the list makes no claim to exhaustiveness, but a supplementary list is given (p. 270) of birds that may be expected to occur in the district, either as residents, regular migrants or stragglers.

The scientific names and numbers used are those given in the *body* of Wait's *Manual of the Birds of Ceylon*, 2nd edition. Those who are interested in ornithological nomenclature are recommended to refer to the Appendix of that volume (p. 465) in order to find the scientific names of species as ultimately adopted in the *Fauna of British India, Birds*, 2nd edition by E. C. Stuart-Baker. It is necessary however, to point out that even these names are not final as many of them have been still further altered by H. Whistler and others, and the process is still



going on with unabated vigour. Owing to these perpetual changes in nomenclature it has come to pass that, among birds and some other forms of life, scientific nomenclature has become more nuisance than it is worth. Writers on birds have forgotten that a name is but a convenient handle and that the usefulness of handles depends mainly upon their being firmly fixed; and as a result, almost every new book or paper on birds upsets many long-established names in the vain attempt to achieve finality. Would it not be far better to 'save up' all necessary changes for periods of, say 25 or 50 years and then publish them all at once instead of continuing indefinitely the present practice of name-juggling?

Except where otherwise stated the birds were either seen or, in a few cases, heard to such advantage as to leave no doubt in my mind as to their identity.

A brief account of the main localities visited will probably make the list more helpful. The district is in the 'dry zone' and has an average annual rainfall of approximately 40 inches, the wet season being in November to January.

*Tissamaharama.* Observations were made in the resthouse grounds, on the margin of the tank, in paddy-fields, and at a shallow, weedy swamp about a mile from the resthouse.

*Vilapala Wewa.* A camping place on a grassy plain which surrounds a fresh-water lake cut off from the sea by sand-dunes. A short distance inland from the camping ground there are several rocky masses arising from the sea of jungle.

*Butawa Modera.* A camping site on the sea coast, flanked by a small lewaya (salt lagoon) and not far from a large grassy 'park'. There is a high slab of rock forming a slight promontory, from the top of which a good view can be obtained of the surrounding country.

*Katagamwva.* A large weedy tank, set in jungle of fairly open character.

*Talgasmankada.* A camping site near the Menik Ganga (River) about four miles from its mouth. It is situated in 'park country' which gives place, along the river, to tall forest consisting mainly of large Kumbuk trees (*Terminalia glabra*), with scanty undergrowth so that one can progress along the river bank without much difficulty. This tall river-side forest was found to contain many kinds of birds which were not noticed elsewhere in the district, including several species which one is accustomed to consider more characteristic of the wet zone.

A mile or so from the camping site there occur several striking masses of gneiss rising in enormous, precipitous boulders to a height of several hundred feet from the plain. These afford an environment suited to the requirements of several kinds of birds which would otherwise be absent. The rock nearest to Talgasmankada is called Moderagalla.

*Yala.* The headquarters of the Forest Officer in charge of the Game Sanctuary. It is situated at the mouth of the Menik Ganga and, apart from the proximity of the sea, resembles Talgasmankada in its main features in relation to bird life.

*Pahala Potana.* A camping site in the heart of the Sanctuary on the cart-track from Yala to Pottuvil. There is a grassy plain, a mile in diameter, through which meanders a small stream, the Nabadagas Ara which spreads out to form a small lagoon, the Pahala Potana Lewaya.

1. The Black Crow, *Corvus coronoides culminatus*. Seen at Tissamaharama, Talgasmankada, Pahala Potana, Vilapalawewa, Katagamuwa.
2. The Ceylon House Crow, *Corvus splendens protegatus*. Noted at Tissamaharama but not further into the region covered by these notes.
6. The Ceylon Babbler, *Turdoides griseus striatus*. Observed in the Sanctuary but not very common in the area under discussion.
12. Brown-capped Babbler, *Pellorneum fuscicapillum*. Met with in the Sanctuary and at Katagamuwa.
13. The Black-fronted Babbler, *Rhopocichla atriceps nigrifrons*. Seen at Katagamuwa.
14. The Ceylon Iora, *Aegithina tiphia zeylonica*. Seen at Katagamuwa, Pahala Potana, Talgasmankada, Butawa Modera, Tissamaharama. This is one of the most characteristic birds of the district; its calls were to be heard everywhere. The courtship flight of the male is a lovely sight; puffing out all his feathers until he resembles a yellow, black, and white fluffy ball he flies slowly from one bush to another. A male in non-breeding plumage was collected at Katagamuwa.
16. Jerdon's Chloropsis, *Chloropsis jerdoni*. Seen in the Sanctuary and at Katagamuwa.
18. Red-vented Bulbul, *Molpastes haemorrhous haemorrhous*. Katagamuwa, Vilapalawewa, the Sanctuary, Talgasmankada and Tissamaharama.
20. Black-capped Bulbul, *Pycnonotus melanicterus*. Seen at Talgasmankada in the tall river-side forest.

21. White-browed Bulbul, *Pycnonotus luteolus*. Tissamaharama, Talgasmankada, the Sanctuary, Vilapalawewa and Katagamuwa.
25. The Black Robin, *Saxicoloides fulicata fulicata*. Katagamuwa and Talgasmankada.
26. The Ceylon Magpie Robin, *Copsychus saularis ceylonensis*. The Magpie Robin was seen only at Yala; at Katagamuwa, Talgasmankada and the Sanctuary it was specially looked for but not seen. So striking and familiar a bird could hardly have been missed and it seems likely that it is definitely absent from the greater part of the area under discussion.
27. The Shama, *Kittocincla macroura indica*. Katagamuwa and Talgasmankada.
38. The Orange-breasted Blue Flycatcher, *Cyornis tickelliae nesaea*. Found in the tall Kumbuk forest on the bank of the Menik Ganga at Talgasmankada.
40. Indian Brown Flycatcher, *Alseonax latirostris poonensis*. Found at Talgasmankada in the same environment as the preceding species.
43. The Paradise Flycatcher, *Terpsiphone paradisi paradisi*. Talgasmankada, Katagamuwa, Pahala Potana, Vilapalawewa. The usual note of this bird is a harsh monosyllable, but, on one occasion, I heard a male singing a pretty little song to his mate.
45. Ceylon Fantail Flycatcher, *Rhipidura aureola compressirostris*. Seen in the Sanctuary and at Katagamuwa.
47. The Brown Shrike, *Lanius cristatus cristatus*. Met with at Yala and Katagamuwa.
50. The Ceylon Wood-shrike, *Tephrodornis pondiceriana affinis*. Katagamuwa, Pahala Potana.
52. The Small Minivet, *Pericrocotus peregrinus malabaricus*. Katagamuwa.
53. Black-headed Cuckoo-shrike, *Lalage sykesii*. Katagamuwa.
58. ?The White-vented Drongo, *Dicrurus coerulescens leucopygialis*. Drongos were found to be not at all common in the area. One was seen at Katagamuwa and although not certainly identified it was most probably of this species.
60. The Raquet-tailed Drongo, *Dissemurus paradiseus ceylonensis*. I have not seen this bird in the district myself but Mrs. Tutein-Nolthenius reports that she has seen it there several times. It most likely frequents the tall river-side forest.

65. The Tailor-bird, *Orthotomus sutorius sutorius*. Seen in the Sanctuary and at Katagamuwa.
66. The Ceylon Streaked Fantail Warbler, *Cisticola juncidis omalura*. Tissamaharama.
67. Franklin's Wren-warbler, *Franklinia gracilis*. Although not noted on the two trips dealt with in this paper, I saw this pretty little warbler in the environs of Tissamaharama in 1921.
76. The Ceylon Jungle Wren-warbler, *Prinia sylvatica valida*. Seen in the Sanctuary, at Katagamuwa and Talgasmankada.
80. The Black-headed Oriole, *Oriolus xanthornus ceylonensis*. Talgasmankada, Katagamuwa, Pahala Potana and Tissamaharama.
84. The Brahminy Mynah, *Temenuchus pagodarum*. Talgasman-kada and in the Sanctuary.
86. The Common Mynah, *Acridotheres tristis melanosternus*. Not very common in the area. It was noted only in the Sanctuary.
87. The Common Weaver-bird or Baya, *Ploceus philippinus*. Seen at Tissamaharama, Katagamuwa and at Pahala Potana. Nest-building was in process in February.
90. The White-backed Munia, *Uroloncha striata striata*. Seen at Katagamuwa.
93. The Spotted Munia, *Uroloncha punctulata punctulata*. Seen in the Sanctuary.
95. The House-sparrow, *Passer domesticus confucius*. Noted at Tissamaharama but, as was to be expected from the absence of permanent human habitations, not elsewhere in the area.
96. The Eastern Swallow, *Hirundo rustica gutturalis*. Seen at Tissamaharama, Katagamuwa, Talgasmankada, Vilapalawewa and Pahala Potana.
102. The Grey and Yellow Wagtail, *Motacilla cinerea caspica*. Seen on the Menik Ganga at Talgasmankada. The presence of this bird in the low-country was rather a surprise, as during its winter sojourn in Ceylon it usually keeps to the neighbourhood of hill streams.
103. The Grey-headed Wagtail, *Motacilla flava thunbergi*. Seen at Tissamaharama and Vilapalawewa. It affects fields and open grassy plains more than the last and is not so partial to the neighbourhood of running water.
107. The Indian Pipit, *Anthus richardi rufulus*. Seen at Tissamaharama, Talgasmankada, Vilapalawewa and in the Sanctuary.

108. The Skylark, *Alauda gulgula australis*. Seen at Pahala Potana and Vilapalawewa. A pair was collected on the coastal sand-dunes at the latter place.
109. The Bush-lark, *Mirafra assamica affinis*. Found at Vilapalawewa, Talgasmankada, Pahala Potana, and Katagamuwa.
110. The Ashy-crowned Finch-lark, *Pyrrhulauda grisea*. Seen at Pahala Potana, Vilapalawewa, and Palatupana.
113. Loten's Sunbird, *Leptocoma lotenia*. Rather doubtfully identified at Tissamaharama; otherwise not seen.
114. The Purple Sunbird, *Leptocoma asiatica asiatica*. Talgasman-kada, Katagamuwa, Pahala Potana.
116. The Purple-rumped Sunbird, *Leptocoma zeylonica*. Katagamuwa.
120. The Indian Pitta, *Pitta brachyura*. Seen at Katagamuwa. Heard in the Sanctuary, Tissamaharama, Vilapalawewa. It is a very common bird all over this part of Ceylon during the north-east monsoon.
123. The Yellow-fronted Pied Woodpecker, *Leiopicus mahrattensis mahrattensis*. Noted at Vilapalawewa, Katagamuwa, and Pahala Potana.
127. The Red-backed Woodpecker, *Brachypternus benghalensis erithronotus*. Seen at Katagamuwa.
130. The Brown-headed Barbet, *Thereiceryx zeylanicus zeylanicus*. Katagamuwa and in the Sanctuary.
132. The Indian Crimson-breasted Barbet or "Coppersmith", *Xantholaema haemacephala lutea*. Found at Tissamaharama and Katagamuwa.
133. The Small Ceylon Barbet or "Ceylon Coppersmith", *Xantholaema rubricapilla*. A specimen was collected at Talgasman-kada.
136. Common Indian Bee-eater, *Merops orientalis orientalis*. Noted at Tissamaharama, Talgasmankada, Katagamuwa, Palatupana, Pahala Potana. Very common over the whole area wherever the country was sufficiently open to permit its style of hawking.
137. Blue-tailed Bee-eater, *Merops superciliosus javanicus*. Tissamaharama, Katagamuwa, Talgasmankada, Pahala Potana.
138. Chesnut-headed Bee-eater, *Melittophagus erythrocephalus erythrocephalus*. Katagamuwa, Yala and near Vilapalawewa.
139. Pied Kingfisher, *Ceryle rudis leucomelanura*. Common at Tissamaharama. Not seen elsewhere in the district.
140. The Ceylon Kingfisher, *Alcedo atthis taprobana*. Tissamaharama, Talgasmankada, Yala and Pahala Potana.

144. White-breasted Kingfisher, *Halcyon smyrnensis generosa*. In the Sanctuary at Pilinawa.
146. The Large Pied Hornbill, *Anthracoceros coronatus*. Seen at Katagamuwa, Talgasmankada and Pahala Potana. It likes the neighbourhood of water, probably because of the large trees that grow in well-watered places, as, so far as my observations go, it never voluntarily descends to the ground and must depend for its water supply on rain-water accumulated in tree-holes, or more likely, on the juice of the fruits that it eats.
147. The Small Grey Hornbill, *Lophoceros griseus gingalensis*. This bird is not at all common in the area under discussion and was met with only at Talgasmankada in the tall river-side forest. No individual was seen but the unmistakeable cry was heard.
148. The Ceylon Hoopoe, *Upupa epops ceylonensis*. Seen at Tissamaharama, Talgasmankada, Katagamuwa, Yala, Butawa Modera, and Vilapalawewa.
150. Indian House Swift, *Micropus affinis nipalensis*. Vilapalawewa and Talgasmankada. In both places they were flying around high rocky ridges which probably afford suitable breeding caves.
154. The Crested Swift, *Hemiprocne coronata*. Talgasmankada, Tissamaharama, Katagamuwa, Vilapalawewa and Pahala Potana. This swift is easily recognized by its long tail and pale grey back as well as its loud cry "keek-ko". It is the only Ceylonese swift that perches on trees. In December, 1931, near Yala, several young birds were seen with their parents. The young are beautifully mottled and remind one of the Nightjars; possibly this resemblance is an indication of an ancestral relationship with the latter group.
155. The Common Indian Nightjar, *Caprimulgus asiaticus*. Pahala Potana, Yala, Vilapalawewa.
156. Jerdon's Long-tailed Nightjar, *Caprimulgus macrourus atripennis*. Heard at night at Tissamaharama, Katagamuwa, Talgasmankada and Pahala Potana.
164. Indian Plaintive Cuckoo, *Cacomantis merulinus passerinus*. Seen in the Sanctuary and one male collected at Yala.
165. Ceylon Banded Bay Cuckoo, *Penthoceryx sonneratii waiti*. A small female was collected at Talgasmankada.
167. Pied Crested Cuckoo, *Clamator jacobinus taprobanus*. Seen in the Sanctuary, Butawa Modera, Tissamaharama.

169. The Koel, *Eudynamis scolopaceus scolopaceus*. Katagamuwa.
170. The Blue-faced Malkoha, *Rhopodytes viridirostris*. Katagamuwa, Talgasmarkada, Pahala Potana.
172. The Southern Sirkeer Cuckoo, *Taccocua leschenaulti leschenaulti*.  
In December, 1931, I caught a glimpse of a bird, believed to be this, near Kirinde. I have also seen it near Tissamaharama.
173. The Common Coucal, *Centropus sinensis parroti*. Tissamaharama, Katagamuwa.
176. The Large Ceylonese Paroquet, *Psittacula eupatria eupatria*.  
Found in the tall Kumbuk forest on the banks of the Manik Ganga at Talgasmarkada.
177. The Rose-ringed Paroquet, *Psittacula krameri manillensis*.  
Tissamaharama, Talgasmarkada, Katagamuwa.
185. The Fish Owl, *Ketupa zeylonensis zeylonensis*. This bird was reported to me at Katagamuwa by my Collector. I have seen it at Tissamaharama and it is no doubt common in suitable places throughout the district.
187. The Small Ceylon Scops Owl, *Otus scops leggei*. Heard at Talgasmarkada. Its loud "tuk, tok-torok" is unmistakeable (see *Ceylon J. Sci.* (B) XVII, p. 244 for description of the cry).
188. The Collared Scops Owl, *Otus bakkamoena bakkamoena*. Heard at Katagamuwa.
189. The Jungle Owlet, *Glaucidium radiatum malabaricum*. }
190. The Chestnut-backed Owlet, *Glaucidium castanotum*. }<sup>?</sup>  
At Katagamuwa our slumbers were disturbed every night by a small owl, probably one of the two "Owlets", which selected trees close to the camp from which to pour forth its loud and monotonous cries through the greater part of the night. Attempts to deal drastically with it came to naught so its identity must remain a mystery for the present.
197. The Black Eagle, *Ictinaetus malayensis perniger*. A large, very dark eagle was seen at Moderagalla, near Talgasmarkada and was identified, with some mental reservations, as this species.
198. The Ceylon Hawk Eagle, *Limnaetops cirrhatus ceylanensis*.  
Seen among the Kumbuks on the river at Talgasmarkada.
200. The Ceylon Serpent Eagle, *Haematornis cheela spilogaster*.  
Seen at Tissamaharama, Talgasmarkada and Yala.

201. The White-bellied Sea-Eagle, *Haliaetus leucogaster*. Vilapalawewa, Tissamaharama.
202. The Grey-headed Fishing Eagle, *Ichthyophaga ichthyaetus plumbeiceps*. One was seen among the Kumbuks on the river at Yala.
203. Brahminy Kite, *Haliastur indus indus*. Talgasmankada, Vilapalawewa, Pahala Potana.
206. Pale Harrier, *Circus macrourus*.
207. Montagu's Harrier, *Circus pygargus*. }  
 Immature Harriers were seen in the Sanctuary and at Vilapalawewa but their identity could not be certainly established.
209. The Marsh Harrier, *Circus aeruginosus aeruginosus*. Seen in the Sanctuary and at Vilapalawewa.
218. The Shahin Falcon, *Falco peregrinus peregrinator*. A falcon, believed to be this, was momentarily glimpsed as it flew around the big rock at Moderagalla—an ideal place for this species.
221. The Kestrel, *Cerchneis tinnunculus tinnunculus*. Seen at Tissamaharama, Butawa Modera, Vilapalawewa and in the Sanctuary.
223. The Pompadour Green Pigeon, *Dendrophassa pompadora pompadora*. Talgasmankada, Katagamuwa, Yala, Vilapalawewa and Pahala Potana. It is probable that the Orange-breasted Green Pigeon, *D. bincincta leggei*, also occurs in the district.
226. The Green Imperial Pigeon, *Muscadivora aenea pusilla*. Talgasmankada, Yala, Vilapalawewa, Katagamuwa and Pahala Potana.
227. The Bronze-wing Pigeon, *Chalcophaps indica robinsoni*. Talgasmankada, Katagamuwa, Vilapalawewa. At Talgasmankada, in February, a Bronze-wing was put off her nest which was situated at a height of about 7 feet in a straggly bush on the river bank; it was balanced precariously on several intercrossing branches and was the usual ramshackle platform of twigs. It contained, or rather, supported, two young, one of which was well advanced in feathering and would soon be able to fly while the other was very small, naked and still blind and had obviously been hatched only a day or two. After examination they were replaced on their rickety "machan", which had unfortunately become more rickety still in the process of taking down the young birds so that there was some fear lest they should fall through it. However, in handling them I noticed that they had a great power of grip in their feet and this would no doubt enable them to 'stay put'.



232. The Spotted Dove or Ash Dove, *Streptopelia chinensis ceylonensis*. Tissamaharama, Vilapalawewa, Katagamuwa, Talgasmankada, Pahala Potana. One of the commonest birds of the district.
235. The Peafowl, *Pavo cristatus*. Talgasmankada, Katagamuwa, Vilapalawewa, Pilinawa, Pahala Potana, Butawa Modera, Yala. Common throughout the area. At Talgasmankada, while I was sitting at sunset on a log which projected into the river, a young peacock (without train) and a peahen flew into the tall Kumbuk over my head and, after much peering and restlessness, settled themselves to roost among the top branches. In spite of their bulk they were not at all conspicuous.

In flight, the peacock spreads his tail into a broad fan, while the train is strongly compressed. I think it worth while to mention this, because in every picture of flying peacocks known to me the train is represented as sufficiently spread to hide the tail. In walking, the train is normally carried well up, on a level with the back, and not trailing on the ground as usually represented.

Mr. R. P. Gaddum, who also visited the district in February, 1936, informs me that he found a peahen incubating five eggs at Butawa Modera. The nest was near the cart-track leading to Yala.

236. Ceylon Jungle Fowl, *Gallus lafayettii*. Butawa Modera, Katagamuwa, the Sanctuary, Yala. In February, 1936, Jungle-fowl seemed to be much less common than they were in December, 1931. This was possibly due to the hens being engaged in nesting in February and the cocks therefore having less incentive for making themselves heard in challenges to their rivals. However this may be, I cannot but think it a great pity that this fine bird, Ceylon's most ornamental and distinctive avian species, should receive no legal protection beyond the prohibition of snaring or netting it—a prohibition of which no villager dreams of taking any notice. It has always been a mystery to me why the Spur-fowl, which, owing to its excessive shyness, is far better able to take care of itself than the Jungle-fowl, is given the legal status of a 'game-bird' and therefore enjoys the benefit of a close-season and only licensed shooting; while the Jungle-fowl is given no legal protection from unrestricted shooting outside of the Game Sanctuaries. That it responds readily to protection is proved

by the tameness of several cocks which I saw beside the cart-track in the Sanctuary. Instead of precipitately fleeing as this bird usually does, they walked off with little more show of alarm than village fowls. It is high time that the Ceylon Jungle Fowl received at least as much protection as the Peafowl, Spurfowl, and Partridges. That its numbers are steadily diminishing is patent to everyone who knows the jungle.

One of the cocks seen in the Sanctuary had evidently been fighting as his head and comb were very gory and he hobbled off with a pronounced limp.

243. The Ceylon Bustard Quail, *Turnix suscitator leggei*. Tissamaharama, Talgasmankada, Katagamuwa, Pahala Potana. A nest with three eggs was found at Pahala Potana in February. The hens were heard calling their rivals at Katagamuwa. The challenge is a low drumming " krrrrrrrr— " which I had always attributed to the distant tattoo of woodpecker until I saw a female bustard quail in the Museum Zoo performing it. The bird, while drumming, crouches with its beak pointing down and nearly touching the ground. It may be of interest to remark that while on a collecting trip in South India in March 1936, at Alagar Kovil, near Madura, I met an old Tamil herdsman who was using a female bustard quail as a decoy for catching others of its kind. He had the bird in a tiny cage, to one end of which was attached a small netted hoop arranged as a drop-trap, with a spring device which was set off by the foot of the wild bird when it had been decoyed into trying to fight the little captive. The old man was aware that it is the females of this species, not the males, that challenge each other and fight for their mates. He said that males were never caught by means of the decoy.
249. The White-breasted Water-hen, *Amaurornis phoenicurus phoenicurus*. Although this species does not appear in my notes it is almost inconceivable that it does not occur in the area under discussion. However it is evidently not common there.
252. The Purple Coot, *Porphyrio poliocephalus poliocephalus*. Seen at Tissamaharama in a weedy swamp in February.
253. The Indian Stone-Curlew, *Burhinus oedicnemus indicus*. Butawa Modera.
259. The Pheasant-tailed Jacana, *Hydrophasianus chirurgus*. Tissamaharama, Katagamuwa, Vilapalawewa. In February the males appeared to be in full breeding plumage.

261. Red-wattled Lapwing, *Lobivanellus indicus indicus*. Katagamuwa, Tissamaharama, Tagasmankada, Vilapalawewa, Pahala Potana. As April-August is the breeding-season this bird was not unduly demonstrative in December and February.
262. Yellow-wattled Lapwing, *Lobipluvia malabarica*. Seen at Vilapalawewa and Talgasmankada.
265. Eastern Golden Plover, *Pluvialis dominicus fulvus*. Butawa Modera, Pilinawa and Pahala Potana.
267. The Lesser Sand-Plover, *Cirrepedesmus mongolus atrifrons*. Some plovers were seen at Pahala Potana, in the Sanctuary, which appeared to be of this species.
273. The Black-winged Stilt, *Himantopus himantopus himantopus*. Tissamaharama, Palatupana, Vilapalawewa, Pahala Potana.
279. The Common Sandpiper, *Tringa hypoleucos*. Yala, Talgasmankada, Butawa Modera. In spite of its popular name this bird much prefers rocks, in the neighbourhood of water, to sandy places.
280. Wood Sandpiper, *Tringa glareola*. Tissamaharama, Katagamuwa, Pahala Potana. If the foregoing should be called the "Rockpiper" this might be named the "Mudpiper" as it delights in muddy swamps and paddy-fields undergoing the process of asweddumization.
282. The Marsh Sandpiper, *Tringa stagnatilis*. Katagamuwa, Vilapalawewa. This is a greyer bird than either of the previous two species.
297. The Pintail Snipe, *Capella stenura*. Tissamaharama, Katagamuwa, Vilapalawewa, Pahala Potana.
301. Brown-headed Gull, *Larus brunnicephalus*. One specimen in winter plumage was collected at Yala.
303. The Javan Whiskered Tern, *Chlidonias leucopareia javanica*. Vilapalawewa.
306. The Gull-billed Tern, *Gelochelidon nilotica nilotica*. Vilapalawewa.
320. The Spotted-billed Pelican, *Pelecanus philippensis*. Butawa Modera, Pilinawa and Pahala Potana.
324. The Indian Shag, *Phalacrocorax fuscicollis*. Some large cormorants seen at Tissamaharama were probably of this species. Undoubtedly the Little Cormorant, *P. niger* also occurs on tanks in the district but it was not definitely noted.
326. The Darter or Snake-bird, *Anhinga melanogaster*. Tissamaharama, Katagamuwa.

335. The White Ibis, *Threskiornis melanocephalus*. Pahala Potana, Katagamuwa, Tissamaharama.
337. The Spoonbill, *Platalea leucorodia major*. Vilapalawewa, Pahala-potana.
339. The Indian White-necked Stork, *Dissoura episcopa episcopa*. Butawa Modera. Not at all a common bird. I have usually seen it in pairs in the middle of open 'parks' and not in swamps or tank margins.
340. The Black-necked Stork, *Xenorhynchus asiaticus asiaticus*. Seen at a swamp near Palatupana in December, 1931, and at a small, jungle-girt swamp near Pahala Potana, in the Sanctuary, in February, 1936. The second occasion was rather exciting; marching along the cart-track through the jungle we entered the small swamp and lo! a magnificent tusker elephant was standing in it a few yards away, feasting on the lush grass. As our carts approached he took alarm, raised his trunk and pricked his ears and made off across the swamp, disturbing the Black-necked Stork as he did so. It flew heavily away, giving me a fine view of its splendid size, and my only regret was that two such rare sights coming at once proved rather an 'embarrassment of riches'.
341. The Smaller Adjutant, *Leptoptilos javanicus*. Talgasmankada and in the Sanctuary near Yala.
342. The Painted Stork, *Ibis leucocephalus leucocephalus*. Tissamaharama, Vilapalawewa, Talgasmankada, Katagamuwa, Yala.
343. The Open-bill, *Anastomus oscitans*. Katagamuwa.
344. The Eastern Purple Heron, *Ardea purpurea manillensis*. Seen at Tissamaharama.
345. The Eastern Grey Heron, *Ardea cinerea rectirostris*. Pahala Potana, Tissamaharama.
347. The Eastern Large Egret, *Egretta alba modesta*. }
348. The Indian Smaller Egret, *Egretta intermedia intermedia*. }
349. The Little Egret, *Egretta garzetta garzetta*. }

Egrets were common at all tanks and lagoons visited but positive identification was difficult. However there is little doubt that all three of the above species are present throughout the district. At Tissamaharama in February, 1936, a colony of Little Egrets was nesting in the trees on the small islet in the tank opposite to the Resthouse. Many of the birds were displaying and they looked very lovely as the long dorsal plumes

were erected vertically, giving the impression that each snow-white bird was surrounded by a halo of mist. With binoculars their black legs and yellow toes could easily be seen, establishing their identity.

- 350. The Cattle Egret, *Bubulcus ibis coromandus*. Seen at Tissamaharama and in the Sanctuary.
  - 352. The Pond Heron, *Ardeola grayii*. Pahala Potana, Talgasmankada, Tissamaharama, Katagamuwa.
  - 353. Indian Little Green Bittern, *Butorides striatus javanicus*. Seen in December, 1931, among mangroves on the lewaya at Butawa Modera.
  - 359. The Common Flamingo, *Phoenicopterus ruber antiquorum*. Mr. Tutein-Nolthenius has reminded me that we saw a large flock of Flamingoes on the Palatupana Lewaya in February, 1936.
  - 363. The Whistling Teal, *Dendrocygna javanica*. Tissamaharama, Katagamuwa and Vilapalawewa.
  - 369. The Pintail Duck, *Dafla acuta acuta*.
  - 370. The Garganey Teal, *Querquedula querquedula*. }
- Numbers of migratory ducks and teal were seen on a salt lagoon in the Sanctuary in February. They could not be definitely identified but were most probably of these two species.
- 372. The Dabchick or Little Grebe, *Podiceps ruficollis capensis*. Seen at Tissamaharama and it most likely occurs at Katagamuwa and other tanks in the district.

#### SUPPLEMENT

In order to make this list as useful as possible a further list is given below of birds which were not met with by me but which may reasonably be expected to occur in the district.

- 10. The Small White-throated Babbler, *Dumetia albigularis albigularis*. A small pale-brown bird which hops about in small parties among scrub undergrowth, giving vent to low churring notes and, when alarmed, an occasional sharp squeak.
- 19. The Yellow-browed Bulbul, *Iole icterica*. May be looked for in the taller forest along the banks of rivers and around the bases of the large rock-masses that are scattered throughout the district.
- 44. The Ceylon Azure Flycatcher or Black-naped Flycatcher, *Hypothymis azurea ceylonensis*. Easily recognized by its beautiful lavender-blue colour, lively ways, and harsh, loud call-note.

54. The Ceylon Large Cuckoo-shrike, *Graucalus macei layardi*. A grey bird, about the size of a mynah, which frequents the tops of trees and frequently betrays its presence by a cry which is well rendered by Wait as a harsh "kur-eech".
55. The Ashy Swallow-shrike, *Artamus fuscus*. This bird is almost certain to occur in our area.
62. The Ceylon Great Reed-Warbler, *Acrocephalus stentoreus margaritae*. May be expected to occur in the district wherever bulrush beds exist.
63. Blyth's Reed-Warbler, *Acrocephalus dumetorum*. A winter visitor to Ceylon where it may be found anywhere in jungle or shrubbery. It is not partial to reeds.
72. The Green Willow-Warbler, *Acanthopneuste nitidus nitidus*. Widespread in Ceylon during the north-east monsoon.
74. The Large-billed Willow-Warbler, *Acanthopneuste magnirostris*. The Willow-warblers are extremely difficult to discriminate, especially in the non-breeding plumage in which they visit Ceylon.
77. The Ceylon Wren-Warbler, *Prinia inornata jerdoni*. To be looked for in reed-beds, illuk grass and scrub lands. It is very similar in general appearance to the Jungle-Wren-warbler, *P. sylvatica valida* but is smaller.
88. The Striated Weaver-bird, *Ploceus manyar flaviceps*. This Weaver-bird, unlike the Baya, seems to confine itself to bulrush beds growing in water. The nest is very similar in general plan to that of the Baya but is much shorter and is placed among the bulrushes—not hanging from a high branch of a tree as with the latter species. I believe I have seen it at Tissamaharama.
89. The Black-headed Munia, *Munia malacca malacca*. A conspicuous bird with its black head, breast and middle of abdomen, chestnut back, wings and tail, and white flanks.
92. The White-throated Munia, *Uroloncha malabarica*. This is more of a drab, grey-brown bird than the other Ceylonese Munias and has a longer, more pointed tail.
99. The Ceylon Swallow, *Hirundo daurica hyperythra*. Easily distinguished from other swallows by its bright chestnut underparts and rump and by its comparatively broad wings and slow flight.

105. Richard's Pipit, *Anthus richardi richardi*. A winter visitor to Ceylon. It is practically a large edition of the resident Indian Pipit.
111. The Small Ceylon White-eye, *Zosterops palpebrosa egregia*. This bird probably occurs in the tall river-side forest along the Menik Ganga and in similar places.
117. Tickell's Flowerpecker, *Dicaeum erythrorhynchus ceylonensis*. This little bird is almost sure to occur in our area but it was not definitely noted.
119. The Thick-billed Flowerpecker, *Piprosoma squalida squalida*. The same remarks apply to this species as to the last. It is a larger bird than the latter, of a drab greyish brown colour, lighter below, with a rather well-marked moustachial streak and a conspicuously stout, short bill.
124. The Pigmy Woodpecker, *Yungipicus hardwickii gymnophthalmus*. This tiny, pied woodpecker—no bigger than a sparrow—was not seen, but at Katagamuwa a dead stump was found with an abandoned nest-hole bored in it which looked very much like the work of this bird. It is easily overlooked owing to its unobtrusive ways and preference for the tops of dead trees.
125. The Ceylon Rufous Woodpecker, *Micropternus brachyurus lanka*. A bay-coloured bird with dark barring on most of the feathers.
128. The Black-backed Woodpecker, *Chrysocolaptes festivus*. A handsome, large woodpecker with a crimson crest, (yellow in the female), yellow wings (as seen when closed), a black back with a white patch at its upper part joining a broad white stripe which extends from the eye down each side of the neck. Legge reported this species from Tissamaharama and I am under the impression that I have seen it there too.
129. Layard's Woodpecker, *Chrysocolaptes guttacristatus stricklandi*. Very similar to the last except that the back and wings are crimson and the crest in the female is black with round white spots. It probably occurs in tall river-side forest.
143. The Brown-headed Stork-billed Kingfisher, *Ramphalcyon capensis gural*. Although not noted this bird is almost certain to be found along the Menik Ganga and elsewhere in the district. It is found on the Kirindi Oya.
151. The Palm Swift, *Tachornis batassiensis batassiensis*. This little swift must certainly occur in the district, in the neighbourhood of palmyrah palms at least.

184. The Brown Wood Owl, *Strix indranee indranee*. Easily identified by its distinctive cry a loud 'hũ-hũ-hõõ'.
191. The Brown Hawk Owl, *Ninox scutulata hirsuta*. Its nocturnal cry, a clear 'coo-ook', rather reminiscent of the English Cuckoo, affords a ready means of tracing the distribution of this little owl.
192. The Osprey, *Pandion haliaetus haliaetus*. A Winter migrant which may be confidently expected on the tanks and lewayas of the district.
205. The Black-winged Kite, *Elanus coeruleus vociferus*. I have seen this bird at Wirawila and it is sure to occur in our area. In flight it strongly suggests a gull, its predominantly white and grey plumage and long wings contributing to the resemblance. Not infrequently it hovers like a kestrel. It frequents open or sparsely-wooded country.
211. The Ceylon Shikra, *Astur badius badius*. Although not noted this hawk is almost sure to be found in the district.
238. The Blue-breasted Quail, *Excalfactoria chinensis chinensis*. This little quail would probably be found, if searched for in the district in grassy, swampy places.
245. The Indian Blue-breasted Banded Rail, *Hypotaenidia striatagularis*. Very possibly to be found in our area but like most Rallidae it is so secretive that it is easily overlooked.
250. The Indian Moorhen, *Gallinula chloropus indicus*. As this bird is reported by Wait to be now common on the tanks and lagoons of the Hambantota district its discovery in the area under discussion is probably only a matter of search.
251. The Water-cock, *Gallinula cinerea*. This bird too is probably to be found in the Reserve or Sanctuary.
254. The Great Stone-Plover, *Esacus recurvirostris*. To be looked for on sandy beaches or the wide margins of lagoons.
257. The Large Indian Swallow-Plover, *Glareola maldivarum maldivarum*. Reported by Wait from the shores of lagoons in the Hambantota district.
258. The Small Indian Swallow-Plover, *Glareola lactea*. "Fairly common near Hambantota"—Wait. Both species of Swallow-Plovers are partial to wide open stretches of dry mud-flats or sandy beaches in the neighbourhood of lagoons.
260. The Turnstone, *Arenaria interpres interpres*. A Winter migrant which probably occurs in our area.



264. The Eastern Grey Plover, *Squatarola squatarola hypomela*. An occasional Winter visitor to Ceylon.
266. The Large Sand-Plover, *Cirrepedesmus leschenaulti*. A regular Winter migrant to Ceylon.
268. Jerdon's Little Ringed-Plover, *Charadrius dubius jerdoni*. May possibly occur as far south as the Sanctuary.
271. The Indian Kentish Plover, *Leucopoliis alexandrinus seebohmi*. Undoubtedly occurs around the sandy borders of lagoons in the district.
274. The Avocet, *Recurvirostra avocetta avocetta*. Recorded from Hambantota. It is a rare Winter visitor to the Island.
275. The Eastern Curlew, *Numenius arquata orientalis*.
276. The Whimbrel, *Numenius phaeopus phaeopus*.
278. The Terek Sandpiper, *Terekia cinerea cinerea*.
284. The Redshank, *Tringa totanus totanus*.
285. The Greenshank, *Glottis nebularia*.
286. The Ruff and Reeve, *Philomachus pugnax*.
288. The Little Stint, *Erolia minuta minuta*.
289. The Long-toed Stint, *Erolia subminuta*.
291. The Curlew Stint, *Erolia testacea*.
292. The Broad-billed Sandpiper, *Limicola falcinellus falcinellus*. The afore-going small waders are all likely to be found in Winter (or as 'loiterers' even in Summer) around the margins of lagoons. Some of them however have very rarely been recorded.
299. The Painted Snipe, *Rostratula benghalensis benghalensis*. To be looked for in weedy swamps.
304. The White-winged Black Tern, *Chlidonias leucoptera leucoptera*. Recorded from Hambantota in April by Wait.
307. The Smaller Crested Tern, *Thalasseus bengalensis bengalensis*. Sure to be found on the coast during the north-east monsoon.
308. The Ceylon Large Crested Tern, *Thalasseus bergii edwardsi*. A coastal species to be found throughout the year.
309. The Common Tern, *Sterna hirundo hirundo*.
311. The Eastern Rosy Tern, *Sterna dougalli korustes*.
312. The White-shafted Little Tern, *Sterna albifrons sinensis*.
313. The Black-shafted Little Tern, *Sterna albifrons saundersi*.
314. The Philippine Brown-winged Tern, *Sterna anaetheta anaetheta*. Any of the above terns may be expected to occur, either regularly or as stragglers on the coast of the district under discussion.

336. The Glossy Ibis, *Plegadis falcinellus falcinellus*. Probably occurs in our area.
338. The White Stork, *Ciconia ciconia ciconia*. A very rare visitor to Ceylon.
354. The Night Heron, *Nycticorax nycticorax nycticorax*. Must certainly occur in the district and I am under the impression that I have seen flocks of Night Herons flying overhead at dusk at Katagamuwa.
356. The Yellow Bittern, *Ixobrychus sinensis sinensis*.
357. The Chestnut Bittern, *Ixobrychus cinnamomeus*.
358. The Black Bittern, *Dupetor flavicollis flavicollis*.  
These three bitterns are most likely to be found in weedy swamps, tank margins, etc., throughout our area.
360. The Comb-duck, *Sarkidiornis melanotus*. A very rare resident to be found only on the most secluded tanks.
361. The Cotton Teal or Quacky Duck, *Nettapus coromandelianus*.  
To be looked for on weedy or lotus-covered tanks.
367. The Gadwall, *Chaulelasmus streperus*. The only published record of this duck in Ceylon is of one that was shot some years ago at Palatupana and is now in the Colombo Museum. In all probability however it visits Ceylon in small numbers during the Winter in most years. Mr. R. P. Gaddum informs me *in litt.* that he has shot Gadwall on the Nilaveli salt-pans, north of Trincomalee.
- In the same letter Mr. Gaddum states that he found Mallard at Palatupana in February, 1936. However, in an interview subsequently it appeared that the exact identity of the ducks seen and shot by him was not established beyond doubt. Nevertheless it is very likely that the Mallard, *Anas platyrhynchos platyrhynchos* does occasionally visit Ceylon and this is a point that might well be borne in mind by sportsmen.
368. The Common Teal, *Nettion crecca crecca*.
369. The Pintail, *Dafila acuta acuta*.
371. The Shoveller, *Spatula clypeata*.  
These migratory teal and ducks probably visit the district occasionally during the north-east monsoon.

G. M. HENRY.

All blocks illustrating this Part by courtesy of the Survey Department, Ceylon.



## An Annotated List of the Coccidae of Ceylon, with Emendations and Additions to Date

BY

E. ERNEST GREEN, F.R.E.S.

More than ten years have now passed since the completion of the fifth and final part of *The Coccidae of Ceylon*. During that period much new systematic work on the family has been undertaken by various workers, leading to a better conception of the affinities of the several subfamilies, genera and species, and many new species have been added to our Ceylon list.

I have thought, therefore, that a catalogue of the Coccidae of Ceylon (complete to date) may prove useful to the increasing number of students of this obscure but economically important group of insects. The arrangement is mainly that adopted in Mrs. Fernald's *Catalogue of the Coccidae of the World*. I have included only such synonymy as will serve to indicate the correct nomenclature.

Over 2,000 species of Coccidae have already been recorded, throughout the world. It is probable that, before the limit has been reached, this total will have been at least trebled.

The species at present known from Ceylon number a little over 300.

### Subfamily MONOPHLEBINAE

#### 1. *Drosicha variegatus* (Green)

*Monophlebus quadricaudatus*, Green, *Cocc. Ceyl.*, V, p. 434, Pl. CLXXIX, 1922

*Drosicha variegatus*, Morrison, *U. S. Dep. Ag., Tech. Bull.* No. 52, p. 227, 1928

My collection contains a single male from Kandy. The female is still unknown.

#### 2. *Drosicha quadricaudatus* (Green)

*Monophlebus quadricaudatus*, Green, *Cocc. Ceyl.*, V, p. 434, Pl. CLXXIX, 1922

*Drosicha quadricaudatus*, Morrison, *U. S. Dep. Ag., Tech. Bull.* No. 52, p. 226, 1928

My only two examples were taken at Peradeniya and Kandy, respectively. (The foregoing two species are known only from the male

sex and are referred provisionally to the genus *Drosicha*, as their characters agree with Indian species of that genus. It is remarkable that no females of the genus *Drosicha* have, as yet, been recorded from Ceylon.)

### 3. *Drosichiella phyllanthi* (Green)

*Monophlebus contrahens*, Green, *Cocc. Ceyl.*, V, Pl. CLXXVI, 1922, (Wrongly determined)

*Monophlebus (Drosicha) phyllanthi*, Green, *Ann. & Mag. Nat. Hist.*, Ser. 9, Vol. xii, p. 168, July 1923

*Drosicha phyllanthi*, Morrison, *U. S. Dep. Ag., Tech. Bull.* No. 52, p. 225, 1928

Occurs on the stems of various woody plants, including *Phyllanthus* spp. My collection contains examples from Haldummulla, Kandy, Matale and Wellawaya. The genus *Drosichiella* differs from *Drosicha*.

### 4. *Monophlebus furcatus* Green

Green, *Cocc. Ceyl.*, V, p. 433, Pl. CLXXVII

This is another species that is known only from the male, the only examples having been caught on the wing. It is possible, as mentioned in my Monograph, that my *furcatus* may be a synonym of *M. atripennis* of Burmeister. Morrison has suggested that it may eventually prove to be the male of one of the several species of *Walkeriana* that I have described from Ceylon or, possibly of *Hemaspidoproctus cinerea*, of which males are unknown.

### 5. *Walkeriana floriger* (Walker)

*Coccus floriger*, Walk., *Cat. Br. Mus. Homopt.*, IV, Suppl., p. 205, 1858

*Walkeriana floriger*, Green, *Cocc. Ceyl.*, V, p. 445, Pl. CLXXXIV

On stems of *Litsea zeylanica* and *Grevillea robusta*, Pundaluoya: Believed to have a life extending over several years. Apparently a montane species, having been taken only at an altitude circa 4,000 ft.

### 6. *Walkeriana ovilla* Green

Green, *Cocc. Ceyl.*, V, p. 448, Pl. CLXXXV, 1922

On stems of *Eugenia subavenis* and *Michelia nilagirica*. My examples were all taken on trees growing in the Botanic Gardens at Hakgala.

7. *Walkeriana compacta* Green

Green, *Ind. Mus. Notes*, IV, No. I, p. 5, 1896. *Cocc. Ceyl.*, V, p. 446, Pl. CLXXXV

On the stem of an undetermined tree. I have taken this species on one occasion only—in the Kelani Valley. The Drs. Sarasin subsequently sent me other examples, taken in an unstated locality (in Ceylon).

8. *Walkeriana senex* Green

*Ind. Mus. Notes*, IV, No. 1, p. 5, 1896. *Cocc. Ceyl.*, V, p. 447, Pl. CLXXXVI

The type was taken on *Dodonaea viscosa*, at Puttalam. Other examples have been found on *Citrus* (Haldummulla), on 'mangrove' (Negombo), on *Grevillea robusta* (Galagedara), and on unidentified plants (Kandy and Chilaw).

9. *Hemaspidoproctus cinereus* (Green)

*Walkeriana cinerea*, Green, (*sine descr.*) *Mem. Dep. Ag. Ind.*, II, (2), p. 18, 1908  
*Aspidoproctus cinerea*, Green, *Cocc. Ceyl.*, V, p. 450, Pl. CLXXXVIII

On stems of various trees, including *Grevillea*, *Citrus*, *Terminalia* and *Thespesia*; Pundaluoya. Occurs in S. India also.

10. *Hemaspidoproctus euphorbiae* (Green)

*Walkeriana euphorbiae*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 5, 1896  
*Aspidoproctus euphorbiae*, Green, *Cocc. Ceyl.*, V, p. 452, Pl. CLXXXIX

On the fleshy branches of *Euphorbia antiquorum*: Hambantota and Habarana.

11. *Labioproctus polei* (Green)

Green, *Cocc. Ceyl.*, V, p. 453, Pl. CXC  
*Walkeriana polei*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 5, 1896

On the smaller branches of *Dodonaea viscosa*, *Psidium guajava* and *Eugenia rotundifolia*: Chilaw: Dolosbage: Mahintale: and Nuwara Eliya. Received also from India, (on an undetermined plant) and from Java, (on *Citrus*). Both sexes of this fine species are known. The male sacs are usually attached to the foliage of the plant, the females affecting the smaller branches.

**12. *Nietnera pundaluoya* Green**

Green, *Cocc. Ceyl.*, V, p. 455, Pl. CXCI, 1922

On *Litsea*, *Cinnamomum*, *Mallotus*, *Loranthus*, *Eurya*, *Psychotria* and *Vitis* spp. Pundaluoya: Watawela: Maskeliya: Nuwara Eliya: Hakgala: Horton Plains: Bandarawela: Haldummulla: Pattipola: and Namunukuli. Occurring singly; the earlier stages on the foliage, the more advanced stages on the stems of the plants. Apparently confined to the hill districts.

**13. *Icerya purchasi* Mask.**

Maskell, *Trans. N. Z. Inst.*, XI, p. 221, 1878

Green, *Cocc. Ceyl.*, V, p. 436, Pl. CLXXX

This is a comparatively recent introduction into Ceylon. It has been recorded from India and is a notorious pest in many other countries. Its principal host plant, in Ceylon, is said to be *Acacia decurrens*.

**14. *Icerya aegyptiaca* (Dougl.)**

*Crossotosoma aegyptiacum*, Douglas, *Ent. Mon. Mag.* XXVI, p. 79, 1890

Green, *Cocc. Ceyl.*, V, p. 439, Pl. CLXXXI

An abundant and widely spread species throughout the Island and in most tropical and subtropical countries. It occurs on a large variety of plants.

**15. *Icerya tangalla* Green**

Green, *Ind. Mus. Notes*, IV, No. 1, p. 6, 1896

Green, *Stylops*, I, pt. 2, p. 32, 1932

This species, originally described (loc. cit.) in 1896, was later regarded as a synonym of *aegyptiaca*, which it so closely resembles. Subsequent careful examination proved it to be distinct, there being a constant difference in the character of the dermal pores, and it has consequently been reinstated under its original name. My collection contains examples from Tangalla, Baddegama, Chilaw, Colombo, Peradeniya and Pundaluoya. The species has also been received from India. Its host-plants appear to be almost as varied as those of *aegyptiaca*.

16. *Icerya seychellarum* (Westw.)

*Dorthisia seychellarum*, Westwood, *Gard. Chron.*, p. 830, 1855

*Icerya crocea*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 6, 1896

*Icerya seychellarum*, Green, *Cocc. Ceyl.*, V, p. 440, Pl. CLXXXII

I have taken this species, in Ceylon, on *Croton*, *Acalypha*, *Grevillea robusta*, *Pterospermum suberifolium* and *Cocculus* sp. The waxy covering may vary from canary-yellow to white, with intermediate parti-coloured individuals. The species is distributed throughout the tropical areas of both Hemispheres, possibly owing to the fact that it is a frequent pest of the sugar-cane.

17. *Icerya pilosa* Green

Green, *Ind. Mus. Notes*, IV, No. 1, p. 6, 1896. *Cocc. Ceyl.*, V, p. 442, Pl. CLXXXIII

A littoral species, occurring abundantly on the grass *Spinifex squamosus*, which vegetates on the sandy shores of Chilaw and other coastal areas. Received also from India, in similar situations.

Though not noted in my description of the species, the inner margin of the falcate claws is distinctly sinuate, though not definitely serrate.

18. *Icerya pilosa nardi* Green

*Icerya seychellarum* var *nardi*, Green, *Cocc. Ceyl.*, V, p. 441, Pl. CLXXXIIa, figs. 17-23, 1922

This insect (of which only a single example has been taken) was found on 'Mana grass' (*Andropogon nardus*), on uncultivated land at Diyatalawa. Though resembling *I. pilosa* in structural characters, its much larger size (6 mm., while the largest example of the type species does not exceed a length of 4 mm.), coupled with the very definitely serrate claws (see fig. 17 *loc cit.*), suggests that it may eventually prove to be a distinct species. The montane habitat, alone, lends colour to this suggestion. It is much to be desired that further search should be made for it the neighbourhood of its discovery.

## Subfamily MARGARODINAE

19. *Kuwanlia zeylanica* (Green)

Green, *Cocc. Ceyl.*, V, p. 425, Pl. CLXXV

*Monophlebus zeylanicus*, Green, *Ind. Mus. Notes*, IV, p. 6, 1896.

In this subfamily the adult insects (of both sexes) have fully developed and functional limbs, while the nymphal insects are either completely



legless and pupiform, or are provided with rudimentary limbs only. *Kuwania zeylanica* is our only representative in Ceylon.

It occurs on *Antidesma bunius*, on the stems of which the bright orange-coloured females may be found resting. The pupiform nymphs are enclosed within cells in the bark of the tree.

#### Subfamily ORTHEZINAE

##### 20. *Orthezia insignis* Dougl.

Douglas, *Journ. Quekett Micro. Club*, p. 169, 1897. *Ent. Mon. Mag.*, XXIV, p. 169, 1889

Green, *Cocc. Ceyl.*, V, p. 418, Pl. CLXXIV

This troublesome pest made its first appearance in our Island in 1893. The origin of introduction is a moot point. It is known to have occurred in the plant houses at Kew, but the authorities at the Royal Gardens repudiate the possibility of its introduction with plants from there. It was first noticed, by Dr. Trimen, in the Botanic Gardens at Peradeniya, where it spread with alarming rapidity. Though popularly known as 'The Lantana Bug', it has a very long list of food-plants and may be regarded as being practically omnivorous.

The country of its origin is apparently unknown; but it has been recorded from North and South America, from South Africa, India and the Dutch East Indies.

#### Subfamily ASTEROLECANIINAE

##### 21. *Asterolecanium exiguum* Green

Green, *Cocc. Ceyl.*, IV, p. 315, Pl. CXVIII, figs. 6-11, 1909

A small and inconspicuous species, on the undersurface of foliage of a bamboo. Yatiyantota.

##### 22. *Asterolecanium rubrocomatum* Green

Green, *Cocc. Ceyl.*, IV, p. 316, Pl. CXIX, 1909

On the upper surface of a species of bamboo. Yatiyantota. This species is distinguished by the bright red marginal fringe and (in fresh examples) by the presence of a pair of scarlet tufts on the dorsum of the thorax. In the synoptical list of species the name is wrongly given as *rubrocoronatum*.

**23. *Asterolecanium tenuissimum* Green**

Green, *Cocc. Ceyl.*, IV, p. 318, Pl. CXX, figs. 1-4, 1909

A very elongate and slender species; on both surfaces of bamboo foliage. Udagama and Yatiyantota.

**24. *Asterolecanium udagamae* Green**

Green, *Cocc. Ceyl.*, IV, p. 319, Pl. CXX, figs. 5-9, 1909

On the foliage of a bamboo. Udagama.

**25. *Asterolecanium flavociliatum* Green**

Green, *Cocc. Ceyl.*, IV, p. 322, Pl. CXXI, figs. 1-5, 1909

On the smaller branches of *Arundinaria* sp.; usually concealed beneath the leaf sheaths. Pundaluoya.

**26. *Asterolecanium pudibundum* Green**

Green, *Cocc. Ceyl.*, IV, p. 323, Pl. CXXII, figs. 6-10, 1909

Concealed beneath the leaf sheaths, on the smaller branches of *Arundinaria* sp. Pundaluoya.

**27. *Asterolecanium ceriferum* Green**

Green, *Cocc. Ceyl.*, IV, p. 324, Pl. CXXIII, 1909

On the foliage of a species of bamboo, the insects resting in shallow depressions on the surface of the leaf. Bogawantalawa.

**28. *Asterolecanium ceriferum prominens* Green**

Green, *Cocc. Ceyl.*, IV, p. 326, Pl. CXXIII, fig. 5, 1909

On the undersurface of the small-leaved bamboo, *Oxytenanthera thwaitesii*. Nuwara Eliya.

The difference in the form of the female test may possibly be due to some structural difference in the texture of the foliage in this plant.

**29. *Asterolecanium coronatum* Green**

Green, *Cocc. Ceyl.*, IV, p. 327, Pl. CXXIV, 1909

Densely clustered on the old stems of the 'Giant Bamboos' (*Dendrocalamus giganteus* and *Gigantochloa aspera*). Peradeniya.

30. ***Asterolecanium bambusae* Bdv.**

Boisduval, *Insectologie Agricole*, 1869

Green, *Cocc. Ceyl.*, IV, p. 328, Pl. CXXV, 1909

A very abundant species; occurring, in Ceylon, on the stems (very occasionally on the foliage) of various species of bamboo. Recorded also from India, Japan, Samoa, Mauritius, Egypt, Algeria, Rhodesia, the West Indies, Grenada and Brazil. It has also become naturalized on bamboos in the palm house at the Royal Gardens, Kew.

31. ***Asterolecanium tumidum* Green**

Green, *Cocc. Ceyl.*, IV, p. 330, Pl. CXXI, figs. 6-10, 1909

On the foliage of bamboo. Udagama.

32. ***Asterolecanium delicatum* (Green)**

*Planchonia delicata*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 5, 1896

*Asterolecanium delicatum*, Green, *Cocc. Ceyl.*, IV, p. 332, Pl. CXXVI, 1909

On the undersurface of *Arundinaria* sp. Pundaluoya.

33. ***Asterolecanium solenophoroides* (Green)**

*Planchonia solenophoroides*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 6, 1896

*Asterolecanium solenophoroides*, Green, *Cocc. Ceyl.*, IV, p. 334, Pl. CXXVII, 1909

This is a minute and inconspicuous species occurring, often in association with *A. lanceolatum*, on the undersurface of the foliage of *Arundinaria* sp. Pundaluoya.

34. ***Asterolecanium lanceolatum* (Green)**

*Planchonia miliaris-longa*, (part), Green, *Ind. Mus. Notes*, IV, p. 5, 1896

*Asterolecanium lineare*, Green, *Cocc. Ceyl.*, IV, p. 336, Pl. CXXVIII, 1909

*Asterolecanium lanceolatum*, Green. Prefatory note to *Cocc. Ceyl.*, IV, and V, Append, p. 461

Crowded on both surfaces of *Arundinaria* sp. Pundaluoya. A confusion of two species, together with a preoccupied name, has complicated the nomenclature of this insect. As explained in the Prefatory Note to Part IV, the name *lineare* was already occupied by a distinct species described by Lindinger.

**35. *Asterolecanium longum* Green**

*Asterolecanium miliaris-longum*, Green, *Cocc. Ceyl.*, IV, p. 339, Pl. CXXII, figs. 5-8, 1909

On the foliage of *Bambusa oliveriana*, Peradeniya. Though at first regarded as a variety of *A. miliaris*, I now believe that it should rank as a distinct species, owing to its distinct habitat and its more elongate form. The species also occurs in India and Fiji, and has been recorded from Florida, U. S. A.

**36. *Asterolecanium pseudomiliaris* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, No. 4, p. 1036, fig. 39, 1922

On the foliage of *Bambusa* sp. Peradeniya. At present known only from Ceylon.

**37. *Asterolecanium aureum* (Boisd.)**

*Coccus aureus*, Boissduval, *Insectologie Agricole*, II, p. 301, 1868

*Asterolecanium greeni*, Marchal, *Bul. Mus. d'Hist. Nat.*, VII, p. 448

*Asterolecanium aureum*, Green, *Cocc. Ceyl.*, IV, p. 320, Pl. CXIII, figs. 1-5, 1909

Occurring singly, on the foliage of various cultivated orchids. Peradeniya. Recorded also from the West Indies and from plant houses in Europe. A relatively large and decorative species, with a long fringe which is divided into packets at regular intervals.

**38. *Asterolecanium thespesiae* Green**

Green, *Cocc. Ceyl.*, IV, p. 331, Pl. CXXII, figs. 1-5, 1909

On small branches of *Thespesia populnea*. Jaffna. The insects occupy shallow pits in the bark of the plant, in which habit it resembles *A. variolosum* and *A. pustulans*. It differs from both these species in having a double marginal series of 8-shaped pores.

**39. *Asterolecanium gutta* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, No. 4, p. 1035, fig. 37, 1922

On young branches of *Calophyllum walkeri*. Pattipola. The yellow tests resemble small congealed drops of Gamboge.

**40. *Asterolecanium loranthi* Green**

Green, *J. Bombay Nat Hist. Soc.*, XXVIII, No. 4, p. 1036, fig. 38, 1922

On *Loranthus neelgherrensis*. Hakgala.

**41. *Polea ceylonica* (Green)**

*Pollinia ceylonica*, Green, *Cocc. Ceyl.*, IV, p. 341, Pl. CXXX, 1909

*Polea ceylonica*, Green, *Cocc. Ceyl.*, V, p. 462, 1922

On the foliage (undersurface) of *Calophyllum walkeri*. Ramboda and Badulla (Nemunakuli). A rare montane species, occurring in dense jungle.

**42. *Amorphococcus mesuae* Green**

Green, *Ent. Mon. Mag.*, XXXVIII, p. 261, fig. 2, 1902

Green, *Cocc. Ceyl.*, IV, p. 343, Pl. CXXX, 1909

Forming rounded or conical ligenous galls on the smaller branches and twigs of *Mesua ferrea*. Paradeniya. The insects occupy distinct cavities in the galls. Adult female fleshy, without definite form or characters; usually enveloped in a thin nymphal pellicle which forms a lining to the cavity of the gall. Larva with a fringe of paired, curling waxy filaments.

**43. *Cerococcus ornatus* Green**

Green, *Cocc. Ceyl.*, IV, p. 306, Pl. CXV, p. 1909

Insects enclosed in waxy tests, with stout conical processes of a brilliant scarlet colour. On the stems of *Coffea arabica* and *Carissa* sp. Pundaluoya and Kayts Island. Recorded also from India. A variety with white (in place of crimson) processes on the test occurs on *Psychotria elliptica*, in Formosa.

**44. *Cerococcus albospicatus* Green**

Green, *Cocc. Ceyl.*, IV, p. 308, Pl. CXVI, 1909

On the bark of *Symplocos obtusa*. Nuwara Eliya. A very decorative species; the test with dorsal and marginal series of long, stout, white processes, with short crimson processes in the intervals.

**45. *Cerococcus roseus* Green**

Green, *Cocc. Ceyl.*, IV, p. 310, Pl. CXVII, 1909

On the branches of an undetermined tree. Trincomali. The whole test of this species, with its marginal series of processes, is of a rosy hue. When crowded together the form of the individual insects is obscured and the mass assumes the appearance of a covering of pink plush.

46. **Cerococcus hibisci** Green

Green, *Mem. Dep. Ag. Ind.*, Entom. Ser., II, No. 2, p. 19, Pl. II, figs. 2-4, 1908  
 Green, *Cocc. Ceyl.*, V, p. 465, 1922

On *Tephrosia candida*. Peradeniya. Originally described from examples received from India, where the species was occurring on *Gossypium* and *Hibiscus liliifolium*. When fresh, the tests are thickly coated with a reddish tomentum, from which projects tufts of coarse glassy filaments. In older examples the tomentose covering is usually found to be denuded, exposing the corneous globular test.

47. **Lecaniodiaspis azadirachtae** Green

Green, *Cocc. Ceyl.*, IV, p. 298, Pl. CXII, 1909

The insects occupy shallow pits in the bark of the 'Margosa' tree (*Azadirachta indica*). Jaffna.

48. **Lecaniodiaspis malaboda** Green

Green, *Cocc. Ceyl.*, IV, p. 300, Pl. CXIII, 1909

On branches of *Myristica laurifolia* ('Malaboda'). Pundaluoya. Occurring also on *Bocagea obliqua*. Watawela. A highly convex species, characterized by a series of stout, white, waxy processes on the dorsum.

49. **Lecaniodiaspis mimusopis** Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, No. 2, p. 1034, fig. 36, 1922

On the bark of *Mimusops hexandra*. Hambantota. By far the largest known species of the genus. Margin with a close series of broad, conical, waxy processes. Judged by external characters alone, the insect might be mistaken for a species of *Walkeriana*.

50. **Anomalococcus cremastogastri** Green

Green, *Ent. Mon. Mag.*, XXXVIII, p. 261, 1902  
 Green, *Cocc. Ceyl.*, IV, p. 303, Pl. CXIV

Invariably enclosed within the carton nests of the ant—*Crematogaster dohrni*, on stems of various trees, more particularly on *Trema orientalis*. Peradeniya; Maha Illupalama; Trincomali and Mahintale. At present known only from Ceylon, though closely allied species occur in India, Malaya, Sumatra and Japan.

## Subfamily DACTYLOPIINAE

51. *Dactylopius indicus* (Green)

Green, *Cocc. Ceyl.*, V, p. 358, Pl. CXL, 1922

*Coccus cacti* var. *ceylonicus*, Green (nom. nud.), *Ind. Mus. Notes*, IV, 1, p. 7, 1896

*Coccus indicus*, Green, *Mem. Dep. Ag. Ind.*, II, p. 28, 1908

On the 'Prickly Pear' (*Opuntia monacantha*). Occurring sporadically at Hambantota, Tangalla, Jaffna and probably in other localities where this particular species of *Opuntia* survives. Found also in parts of India. Other species of *Opuntia* appear to be immune, but *monacantha* soon wilts, when attacked, and eventually dies. This insect is consequently of value in helping to eradicate a troublesome pest. It is a matter of regret that the old established name of *Coccus*, for the Cochineal Insects, has been superseded.

52. *Halimococcus borassi* Green

Green, *Cocc. Ceyl.*, V, p. 360, Pl. CXLI, 1922

At the base of fronds of the Palmyra Palm (*Borassus flabelliformis*). Peradeniya. Though observed in one locality only, it probably occurs in other parts of Ceylon where the Palmyra Palm has been naturalized. In the description of the species (loc. cit.) it is stated that the nymphal stage of the insect has not been recognized. Later observations, by W. J. Hall, on *H. thebaica*, show that the so-called puparium is actually the indurated derm of the nymph. The exact systematic position of this genus is still in doubt. F. S. Stickney, in an exhaustive study of *Phoenicoccus* and its nearest allies, (amongst which he includes *Halimococcus*) suggests that its proper position may be in the Diaspine group.

53. *Erioides cuneiformis* Green

Green, *Cocc. Ceyl.*, V, p. 365, Pl. CXLV, 1922

On the upper surface of leaves of *Eugenia oligantha*; also on species of *Calophyllum*. Nuwara Eliya. The felted ovisacs are almost invariably situated at the base of the leaf, lying along the groove above the midrib.

54. *Erioides rimulae* Green

Green, *Cocc. Ceyl.*, V, p. 366, Pl. CXLVI, 1922

In crevices of the bark of *Phyllanthus* sp. and *Euonymus* sp. Nuwara Eliya and Bandarawela. Also on the stems of *Loranthus longiflorus*. Hewaheta.

**55. *Formicococcus humboldtiae* (Green)**

*Lachnoidius humboldtiae*, Green, *Cocc. Ceyl.*, V, p. 400, Pl. CXLIX, 1922

Although peculiar in the possession of more than 8 setae on the anal ring, it is now realized that this insect cannot be congeneric with species of Maskell's genus *Lachnoidius*. Takahashi has since founded a new genus *Formicococcus*, for a species (*cinnamomi*) that has characters similar to those of my *humboldtiae*. Found in the hollow joints of young branches of *Humboldtia laurifolia*, attended by ants. At the distal extremity of each joint there is a minute passage communicating with the cavity of the internode below it. This passage is enlarged by ants of several species which make their nests in the cavities, but is not of sufficient size to permit of the ingress or exit of the full grown insects. It is probable that the ants introduce the young larvae and plant them on the inner walls of the cavity, where they are imprisoned for the remainder of their existence. Yatiyantota.

**56. *Farinococcus formicarii* (Green)**

*Tylococcus formicarii*, Green, *Cocc. Ceyl.*, V, p. 368, Pl. CXLVII, 1922

In the carton nests of the ant *Crematogaster dohrni*, on *Grewia columnaria*. Maha Illuppalama.

**57. *Farinococcus simplicior* (Green)**

*Tylococcus simplicior*, Green, *Cocc. Ceyl.*, V, p. 369, Pl. CXLVIII, 1922

On an undetermined plant, in shelters constructed by the large 'Red Ant' *Ecophylla smaragdina*. The foregoing two species are now referred to Morrison's genus *Farinococcus*, to which they conform more closely than to Newstead's *Tylococcus*.

**58. *Pedronia strobilanthis* Green**

Green, *Cocc. Ceyl.*, V, p. 364, Pl. CXLIV, 1922

On undersurface of leaves of *Strobilanthes* sp. Pedrotalagala, Nuwara Eliya. The dorsum is characterized by a series of stout, conical spines.

**59. *Pedronia strobilanthis-tenuispina* Green**

Green, *Cocc. Ceyl.*, V, p. 364, Pl. CXLIV, fig. 8, 1922

On the same host-plant. Namunakuli (Badulla). Differs from the type in the form of the dorsal spines, which are slender and acute.



**60. *Phenacoccus glomeratus* Green**

Green, *Cocc. Ceyl.*, V, p. 389, Pl. CLX, 1922

On young stems of *Hibiscus esculentus* and *Thespesia lampas*. Peradeniya. The insects are concealed beneath a mass of cottony secretion.

**61. *Phenacoccus insolitus* Green**

Green, *Mem. Dep. Ag. Ind.*, Ent. Ser., II, (2), p. 26, 1908

Green, *Cocc. Ceyl.*, V, p. 390, Pl. CLXI, 1922

On foliage of *Cajanus indicus*, *Cyclea burmanni* and *Solanum melongena*. Peradeniya, Colombo and Jaffna. Occurs also in India, on *Sida cordifolia*; and in Mauritius, on *Physalis peruviana*. The elongated ovisacs might be mistaken for those of some species of *Pulvinaria*.

**62. *Phenacoccus iceryoides* Green**

Green, *Mem. Dep. Ag. Ind.*, Ent. Ser., II, (2), p. 26, 1908

Green, *Cocc. Ceyl.*, V, p. 391, Pl. CLXII, 1922

On the twigs and small branches of various plants and trees, e.g., *Odina wodier*, *Callicarpa lanata*, *Murraya koenigii*, *Wendlandia notoniana* and *Tephrosia candida*, Kandy and Badulla. Recorded also from India.

**63. *Phenacoccus ornatus* Green**

Green, *Cocc. Ceyl.*, V, p. 392, Pl. CLXIII, 1922

On foliage of *Jasminum* sp., Haputale and Wellawaya; and on the tea plant, Haldummulla. Recorded also from Southern India, on *Jasminum*.

**64. *Phenacoccus mangiferae* (Green)**

*Pseudococcus mangiferae*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 6, 1896

*Phenacoccus mangiferae*, Green, *Cocc. Ceyl.*, V, p. 393, Pl. CLXIV, 1922

On foliage of *Mangifera indica*. Pundaluoya and Bandarawela. Recorded also from India. Sometimes infesting the leaves so heavily as to cause extensive defoliation.

**65. *Phenacoccus spinosus* Robinson**

Robinson, *Phil. Journ. Sci.*, XIII, sec. D, 4, p. 145, 1918

Green, *Cocc. Ceyl.*, V, p. 394, Pl. CLXIV, fig. 17, 1922

On *Ficus* sp. Peradeniya. Received also from Java, on *Psidium pumilum*. Originally described from the Philippine Islands. Resembling *Phen. mangiferae* very closely, but differing in the number and arrangement of the spinous tracts.

**66. *Ferrisia virgatus* (Ckll.)**

*Dactylopius virgatus*, Cockerell, *The Entomologist*, XXVI, p. 178, 1893

*Pseudococcus virgatus*, Green, *Cocc. Ceyl.*, V, p. 371, Pl. CLXIX, 1922

Widely distributed, on many diverse plants. Kandy; Colombo; Puttalam and Trincomali. Recorded also from India, the Maldiva Islands, Jamaica, the Sandwich Islands, Mauritius, Mexico, Texas, Java, Nigeria and Zanzibar.

**67. *Ferrisia kandyensis* (Green)**

*Pseudococcus kandyensis*, Green, *Cocc. Ceyl.*, V, p. 373, Pl. CL, 1922

On a small wiry grass. Kandy. The adult female is surrounded by a fringe of yellowish, silky tomentum.

**68. *Pseudococcus citri* (Risso)**

*Dortheesia citri*, Risso, *Essai Hist. Nat. des Orangers*, 1913

*Pseudococcus citri*, Green, *Cocc. Ceyl.*, V, p. 375, Pl. CLIII, 1922

Notorious, in Ceylon, as the 'Mealy Bug' of the Coffee tree. It attacks the developing fruit and—when coffee was a staple crop in the Island—sometimes resulted in a considerable loss of crop. It is also a serious pest of many cultivated plants, e.g., *Cacao*, *Citrus*, *Cinchona*, *Anona*, etc. A cosmopolitan species and a common green-house pest in Europe.

**69. *Pseudococcus longispinus* (Targ.)**

*Dactylopius longispinus*, Targioni, *Catalogue*, p. 32, 1869.

*Pseudococcus longispinus*, Green, *Cocc. Ceyl.*, V, p. 383, Pl. CLVIII, 1922

On *Jasminum* and *Lantana*, (Pundaluoya): On *Mimosa*, (Pera-deniya): on cultivated ferns, (Colombo): on *Gossypium*, (Kurungalla): and on many other cultivated plants. Almost as widely spread and cosmopolitan as the previous species, from which it may be distinguished by the fringe of elongate waxy tassels on each side of the body.

**70. *Pseudococcus maritimus* (Ehrhorn)**

*Dactylopius maritimus*, Ehrhorn, *Can. Ent.*, XXXII, p. 315, 1900

*Pseudococcus maritimus*, Green, *Cocc. Ceyl.*, V, p. 384, text. fig. 2, 1922

On *Passiflora* sp. and Tomato plants. Pundaluoya. Until recently recorded from the U. S. A. only, but now recognized as a green-house pest in England. I have records, also, from Germany, Africa, the Canary Islands and Gibraltar.

71. ***Pseudococcus comstocki* (Kuw.)**

*Dactylopius comstocki*, Kuwana, *Pr. Cal. Ac. Sci.*, III, p. 52, 1902

*Pseudococcus comstocki*, Green, *Cocc. Ceyl.*, V, p. 386, text fig. 3, 1922

On *Loranthus* sp., *Trema orientalis* and *Cinnamomum camphora*. Pundaluoya. Superficially resembling both *longispinus* and *maritimus*, from which it can be distinguished only by careful examination of the microscopical characters.

72. ***Pseudococcus lilacinus* Ckll.**

Cockerell, *Pr. Dav., Ac. Sci.*, X, p. 128, 1905

*Dactylopius crotonis*, Green, *J. Econ. Biol.* VI, 2, p. 35, 1911

*Pseudococcus lilacinus*, Green, *Cocc. Ceyl.*, V, p. 380, Pl. CLVII, 1922

On *Codiaeum*, *Castilleja*, *Erythrina*, *Theobroma*, and many other plants. Widely distributed throughout the Island. Recorded also from India, Formosa and Uganda.

73. ***Pseudococcus brevipes* Ckll.**

Cockerell, *The Entomologist*, XXVI, p. 267, 1893

On roots and foliage of the Pineapple. Peradeniya. Recorded also from India. This species has, for many years and by various authors, figured under the name of *Pseudococcus bromeliae* of Bouché, which has now been shown to have no standing as applied to the 'Mealy-bug' of the Pineapple. The first name that is properly applicable appears to be *brevipes* of Cockerell. Several nearly allied species have been confused under the older (discarded) name.

74. ***Pseudococcus cannae* Green**

*Pseudococcus bromeliae*, (wrongly determined), Green, *Cocc. Ceyl.*, V, p. 381, text fig. 1, 1922

*Pseudococcus cannae*, Green, *Stylops*, III, 7, p. 162, 1934

On roots of *Canna* and *Impatiens*. Peradeniya. Recorded also from Egypt and Mauritius. The insect described and figured as *Pseudococcus bromeliae*, in *Cocc. Ceyl.* (loc. cit.), differs from *brevipes* in having limbs and antennae markedly more slender, as well as in more minute structural characters. It is one of the "nearly allied species" noticed in the previous paragraph as having "been confused under the older (discarded) name". As the use of the name *bromeliae* is no longer permissible in the genus, this particular species was left

'high and dry' without a specific name. This lack has now been remedied by the provision of the new name—*cannae*. The description in *Stylops* (loc. cit.) was drawn up from old and faded preparations. Fresh material reveals the presence of an irregular but sharply defined sclerous patch on the caudal lobes, and slight sclerosis surrounding the abdominal cerarii.

**75. *Pseudococcus citriculus* Green**

Green, *Cocc. Ceyl.*, V, p. 377, Pl. CLIV, 1922

On foliage of *Citrus*. Reported also from the Hawaiian Islands. A small and delicate species, superficially resembling *Phenacoccus mangiferae*.

**76. *Pseudococcus monticola* Green**

Green, *Cocc. Ceyl.*, V, p. 378, Pl. CLV, 1922

On the foliage of a dwarf bamboo, locally known as 'Elephant Grass'. On the hills above Maskeliya and at Patipola, at an elevation of about 6,000 feet.

**77. *Pseudococcus debrageasiae* Green**

Green, *Cocc. Ceyl.*, V, p. 388, Pl. CLIX, 1922

On *Debrageasia velutina*, in shelters constructed by the ant—*Crematogaster dohrni*. Pundaluoya and Peradeniya.

**78. *Pseudococcus filamentosus-corymbatus* Green**

Green, *Cocc. Ceyl.*, V, p. 379, Pl. CLVI, 1922

(*Pseudococcus filamentosus* Cockerell, var. *corymbatus*)

Clustered on the terminal branches of *Breynia patens*, where the ovisacs have the appearance of white berries. Also, occasionally, on various other plants. Widely distributed throughout the Island. Recorded also from India.

**79. *Pseudococcus scrobicularum* (Green)**

*Dactylopius scrobicularum*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 7, 1896

*Pseudococcus scrobicularum*, Green, *Cocc. Ceyl.*, V, p. 375, Pl. CLII, 1922

Concealed within small pits beneath the bases of leaves of *Elaeocarpus amoenus*. Pundaluoya. The presence of the insects can be detected

by tufts of white secretion projecting from the apertures of the pits (scrobiculae). This species is doubtfully retained in the genus *Pseudococcus*. Its peculiar characters suggest affinity with *Erioides*.

#### 80. *Pseudococcus* (*Trionymus*) *pulverarius* (Newst.)

*Ripersia pulverarius*, Newstead, *Ent. Mon. Mag.*, XXVIII, p. 145, 1892

*Pseudococcus pulverarius*, Green, *Cocc. Ceyl.*, V, p. 373, Pl. CLI, figs. 1-6, 1922

On grasses; concealed between the stem and the enveloping bases of the leaves. Pundaluoya. Originally described from Great Britain.

#### 81. *Pseudococcus* (*Trionymus*) *bambusae* Green

*Pseudococcus pulcerarius* subsp. *bambusae*, Green, *Cocc. Ceyl.*, V, p. 374, Pl. CLI, figs. 7-10, 1922

Concealed beneath the stipules and stems of a bamboo (*Arundinaria* sp.). Pundaluoya. Though at first placed as a subspecies of *pulverarius*, there can be little doubt but that this should be regarded as a distinct species.

#### 82. *Pseudococcus* *theae* (Ruthfd.)

*Ripersia theae*, Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, p. 111, 1915

"On branches of tea at Peradeniya, June 1913 and July 1914." I have examined Rutherford's type (a single slide) of this insect. It is in such poor condition that few characters can be distinguished, but such as there are make it doubtful if the species has been rightly referred to the genus *Ripersia*. It appears to have a complete marginal series of cerarii, each armed with from 1 to 3 stout lanceolate spines. It would seem to be more at home in the genus *Pseudococcus*.

#### 83. *Geococcus* *radicum* Green

Green, *Ent. Mon. Mag.*, XXXVIII, p. 262, 1902

Green, *Cocc. Ceyl.*, V, p. 361, Pl. CXLII, 1922

In the soil, attached to the roots of grasses and other plants, under stones. Pundaluoya. Nymphs, apparently of the same species, have been found in the Hawaiian Islands. Other species of the same genus occur in Japan and in Dutch Guiana. This genus is most nearly allied to *Rhizoecus*, of which we have, as yet, no representative in Ceylon.

**84. *Pseudantonina bambusae* Green**

Green, *Cocc. Ceyl.*, V, p. 363, Pl. CLXIII, 1922

Concealed between the imbricating stipules of a small bamboo, (*Teinostachyum attenuatum*), Nuwara Eliya.

There is an error of interpretation in my original description of the species, where it is stated that there are crowded clusters of pores "on the dorsum, immediately above the insertion of the limbs". Further study has shown that these pores are really ventral and are associated with the coxae of the 2nd and 3rd pair of legs.

**85. *Antonina bambusae* (Mask.)**

*Sphaerococcus bambusae*, Maskell, *Trans. N. Z. Inst.*, XXV, p. 237, Pl. XVI, figs. 12-19, 1892

*Antonina bambusae*, Green, *Cocc. Ceyl.*, V, p. 397, CLXVII, 1922

On the stems of the 'Giant Bamboos'—(*Dendrocalamus gigantea* and *Gigantochloa aspera*), and on the 'Male Bamboo'—(*Dendrocalamus stricta*). Pundaluoya; Peradeniya and Colombo. Recorded also from Southern India and the Sandwich Islands.

**86. *Antonina indica* Green**

Green, *Mem. Dep. Ag. Ind.*, Ent. Ser., II, p. 2, 1908

Green, *Cocc. Ceyl.*, V, p. 395, Pl. CLXV, 1922

At the base of stems of various grasses. Pundaluoya; Peradeniya; Colombo; etc. Recorded also from India, Formosa, Mauritius and East Africa.

**87. *Antonina maritima* Green**

Green, *Cocc. Ceyl.*, V, p. 396, Pl. CLXVI, 1922

On rhizomes of a sedge (*Cyperaceae*) in sand on the seashore. Colombo. Received also from India, where it is said to occur in wet places.

**88. *Antonina zonata* Green**

Green, *Ent. Mon. Mag.*, 3rd Ser., V, p. 175, 1919

Green, *Cocc. Ceyl.*, V, p. 399, Pl. CLXVIII, 1922

The berry-like female insects are clustered in the axils of the smaller branches of a bamboo. Pundaluoya. The insects are almost invariably attended by ants—(*Crematogaster dohrni*), which construct fibrous shelters over them. Occurs in India also.

## Subfamily ERIOCOCCINAE

89. *Eriococcus araucariae* Mask.

Maskell, *Trans. N. Z. Inst.*, XI, p. 218, 1878

Green, *Cocc. Ceyl.*, V, p. 348, Pl. CXXXIII, 1922

A troublesome pest on the foliage of *Araucaria excelsa*, in Ceylon, making the trees unsightly by reason of the copious growth of sooty fungus that is always associated with the insects. Originally described from New Zealand, but now widely distributed. It has been recorded from India, S. Africa, Southern California, the Sandwich Islands and Japan.

90. *Eriococcus nueræ* Green

Green, *Cocc. Ceyl.*, V, p. 347, Pl. CXXXIV, 1922

On the bark of an undetermined tree. Nuwara Eliya.

91. *Eriococcus rhodomyrti* Green

Green, *Cocc. Ceyl.*, p. 352, Pl. CXXXVIII, 1922

On the undersurface of leaves of *Rhodomyrtus roseus*. Nuwara Eliya; Maskeliya; Badulla.

92. *Eriococcus osbeckiae* Green

Green, *Cocc. Ceyl.*, V, p. 355, Pl. CXXXIX

On the foliage of *Osbeckia* sp. Namunakuli Hill, Badulla district.

93. *Eriococcus tenuis* Green

Green, *Cocc. Ceyl.*, V, p. 351, Pl. CXXXVII, 1922

On the undersurface of the foliage of a grass. Pundaluoya; Peradeniya; Kotmali, etc.

94. *Eriococcus bambusæ* Green

Green, *Cocc. Ceyl.*, V, p. 350, Pl. CXXXV, 1922

In the axils of the leaves of *Bambusa* sp. Yatiyantota; Udagama. Apparently confined to the Low Country districts.

95. *Eriococcus transversus* Green

Green, *Cocc. Ceyl.*, V, p. 351, Pl. CXXXVI, 1922

Disposed transversely across the axils of leaves of *Arundinaria* sp. Maskeliya at an altitude of 6,500 feet.

## Subfamily LACCIFERINAE

As a result of an exhaustive study by J. C. Chamberlin, I am compelled to accept a fundamental alteration in the nomenclature of the Lac Insects, which have been known for half a century as *Tachardinae*. The change in the name of the subfamily necessitates corresponding changes in the generic names.

96. *Laccifer lacca* (Kerr)

*Coccus lacca*, Kerr, *Philos. Trans.*, LXXI, p. 374, 1782

*Tachardia lacca*, Green, *Cocc. Ceyl.*, V, p. 408, Pl. CLXXI, 1922

The species is not indigenous in Ceylon, but has been introduced, and successfully established in the Island, as a source of shellac. It is cultivated extensively in India, and has a long list of host plants, of which the more important are *Butea frondosa*, *Zizyphus jujuba*, *Schleichera trijuga* and *Ficus religiosa*.

97. *Laccifer albizziae* (Green)

*Tachardia albizziae*, Green, *Journ. Econ. Biol.*, VI, p. 32, 1911

Green, *Cocc. Ceyl.*, V, p. 411, Pl. CLXXII, 1922

This species occurs indigenously, in localities extending from sea level up to the lower montane zone, and affects the following plants:—*Albizzia stipulata*, *Filicium decipiens*, *Harpullia cupanioides*, *Nephelium litchi*, *Amherstia nobilis*, *Hemicyclia sepiaria*, *Schleichera trijuga*, *Croton lacciferum*, *Theobroma cacao*, *Ficus nervosa* and *Llandolphia* sp. Received also, from India, on *Croton caudatum*. The lac, after incorporation with various colours, is utilized by native craftsmen in the decoration of ceremonial staves and wooden panels.

98. *Metatachardia conchiferata* (Green)

*Tachardia conchiferata*, Green, *Cocc. Ceyl.*, V, p. 407, Pl. CLXX, 1922

On *Excaecaria agallocha*, *Anona palustris*, *Croton lacciferum* and *Mimosa* sp. Kandy; Matale; Jaffna; Tangalla. Known from Ceylon



only. The lac from this species is considered to be superior to that from *albizziae* and is greatly valued by the lac-workers of Matale and Tangalla.

99. **Tachardia lobata** (Green)

*Tachardia lobata*, Chamberlin, *Bull. Ent Research*, XIV, p. 208, 1923

*Tachardia minuta*, Morrison; Green, *Cocc. Ceyl.*, V, p. 414, Pl. CLXIII, 1922

On *Flacourtia ramontchi* and *Fluggea leucopyrus*. Kandy. Recorded also from India. Some confusion has arisen about the correct name of this species: but both Chamberlin and Cockerell agree that the Ceylon insect should be referred to *lobata*. Typical *minuta*, from the Philippine Islands, is a distinct species.

Subfamily LECANIINAE

In spite of the fact that, in Mrs. Fernald's *Catalogue of the Coccidae of the World*, this subfamily is called *Coccinae*, and that the principal genus (*Lecanium*) is referred to by the name of *Coccus*, I prefer to retain (in this paper) the more familiar designation.

The genus *Lecanium*, itself, has been split up and disguised under a multitude of names, some of which I have indicated in brackets. But the boundaries of most of the proposed genera are so indeterminate that it is difficult to assign a particular species to one or other of them with certainty. The only genus (or subgenus) that is unmistakable is *Paralecanium*, which is distinguished by a marginal fringe of flabelliform setae.

100. **Lecanium (Coccus) hesperidum** (L.)

*Coccus hesperidum*, Linnaeus, *Syst. Nat.*, II, 1735

*Lecanium hesperidum*, Green, *Cocc. Ceyl.*, III, p. 188, Pl. LXIII, figs. 8-12, 1904

Not indigenous or common in Ceylon. Occurring, principally, on introduced plants, amongst which may be mentioned *Citrus*, tea and ivy. Elsewhere, of world-wide distribution.

101. **Lecanium (Coccus) signiferum** Green

Green, *Cocc. Ceyl.*, III, p. 197, Pl. LXVIII, 1904

On cultivated *Begonia* plants; also on *Caryota urens* and *Alpinia nutans*. Pundaluoya. Recorded also from India and Italian Somaliland, in both of which places it occurred on *Musa paradisiaca*. It has

been suggested that this is a well marked variety of *hesperidum*; but it may be distinguished from that species not only by its bright green colour and dark cross bands, but by the character of the marginal setae.

102. **Lecanium (Coccus) viride** Green

Green, *Observations on the Green Scale-Bug in connection with the Cultivation of Coffee*, 1886

Green, *Ent. Mon. Mag.*, p. 248, April 1889

Green, *Cocc. Ceyl.*, III, p. 199, Pl. LXIX, 1904

Originally noticed on Coffee, in Ceylon; but now almost omnivorous. It has since become wide-spread on the Indian coffee plantations.

103. **Lecanium (Coccus) elongatum** Sign.

Signoret, *Ann. Soc. Ent. Fr.*, (5), III, p. 404, 1873

*Lecanium longulum*, Douglas, *Ent. Mon. Mag.*, Oct. 1887, p. 97. Green, *Cocc.*

*Ceyl.*, III, p. 221, Pl. LXXX, 1904

The species has a wide range, extending into both Hemispheres. Its host plants are correspondingly numerous. In Ceylon it apparently prefers trees of the Natural Order *Leguminosae*; but has occurred on *Grevillea robusta*, *Anona cherimolia* and *Loranthus longiflorus*.

104. **Lecanium (Coccus) frontale** Green

Green, *Cocc. Ceyl.*, III, p. 192, Pl. LXV, 1904

On undersurface of leaves of *Calophyllum*. Pundaluoya. Possibly a variety of *L. elongatum*.

105. **Lecanium (Coccus) capparidis** Green

Green, *Cocc. Ceyl.*, III, p. 187, Pl. LXIII, 1904

On *Capparis moonii*. Pundaluoya. Not recorded elsewhere.

106. **Lecanium (Coccus) acuminatum** Sign.

Signoret, *Ann. Soc. Ent. Fr.*, (5), III, p. 397, 1873

Green, *Cocc. Ceyl.*, III, p. 195, Pl. LXVII, 1904

On foliage of *Jasminum*. Pundaluoya. Originally described from plant houses, in France.

107. *Lecanium discrepans* Green

Green, *Cocc. Ceyl.*, III, p. 204, Pl. LXX, figs. 1-4, 1904

On the tea plant, attended by ants; sometimes enclosed in nests of *Crematogaster dohrni*. Pundaluoya: Yatiyantota: Passara. Recorded also from India, Sumatra and Formosa.

108. *Lecanium punctuliferum* Green

Green, *Cocc. Ceyl.*, III, p. 205, Pl. LXX, figs. 5-13, 1904

On *Michelia champaca*; enclosed in shelters of *Ecophylla smaragdina*. Peradeniya. I have also received the species from India (on *Dalbergia*) and from Zanzibar (on *Mangifera*).

109. *Lecanium formicarii* Green

Green, *Ind. Mus. Notes*, IV, no. 1, p. 9, 1896. *Cocc. Ceyl.*, III, p. 190, Pl. LXIV, 1904

Enclosed in the nests and shelters of the ant—*Crematogaster dohrni*; on Tea, *Cinchona*, *Macaranga*, *Elaeocarpus* and various shrubs. Not found outside the nests of this ant. Pundaluoya: Balangoda: Kandy. Recorded also from India, in similar situations.

110. *Lecanium ophiorrhizae* Green

Green, *Ind. Mus. Notes*, vol. IV, no. 1, 1896  
Green, *Cocc. Ceyl.*, III, p. 193, Pl. LXVI, 1904

On foliage of *Ophiorrhiza pectinata*. Pundaluoya. Recorded also from India.

111. *Lecanium (Eucalymnatus) tessellatum* Sign.

Signoret, *Ann. Soc. Ent. Fr.*, (5), III, p. 401, 1873  
*Lecanium tessellatum* var. *perforatum*, Newstead: Green. *Cocc. Ceyl.*, III, p. 207, Pl. LXXII, 1904  
*Lecanium subtessellatum*, Green, *Cocc. Ceyl.*, III, p. 206, Pl. LXXI, 1904  
*Lecanium tessellatum-obsolatum*, Green, *J. Bombay Nat. Hist. Soc.*, Dec. 1922, p. 1024

On fronds of *Caryota urens* and several other palms; also on various shrubs. Of almost world-wide distribution throughout tropical and subtropical countries and occurring frequently in hot-houses in temperate regions.

I am convinced that these are all forms of a single species and that the forms are not sufficiently constant to warrant even subspecific status. The reduction of the tessellation may be due to heavy chitini-zation (obscuring the divisions) or to parasitization (resulting in more or less complete suppression).

112. **Lecanium mangiferae** Green

Green, *Ent. Mon. Mag.*, April 1889, p. 249

Green, *Cocc. Ceyl.*, III, p. 216, Pl. LXXVII, 1904

On *Mangifera*, *Cinnamomum* and *Litsea zeylanica*. Pundaluoya and Peradeniya. Recorded also from India, the Seychelle Islands and the West Indies.

113. **Lecanium piperis** Green

Green, *Ind. Mus. Notes*, IV, no. 1, p. 9, 1896

Green, *Cocc. Ceyl.*, III, p. 210, Pl. LXXIV, 1904

On upper surface of *Piper* sp. Pundaluoya. Not recorded elsewhere.

114. **Lecanium piperis-namunakuli** Green

Green, *J. Bombay Nat. Hist. Soc.*, p. 1024, Dec. 1922

On *Piper* sp. Numunakuli Hill, Badulla. Differs from the type in the antennae having 6 (in place of 8) joints only, and in the smaller number (3 instead of from 4 to 6) stigmatic spines.

115. **Lecanium bicruciatum** Green

Green, *Cocc. Ceyl.*, III, p. 214, Pl. LXXVI, 1904

On undersurface of leaves of *Memecylon umbellatum*, *Nothopegia colebrookiana* and various other shrubs. Throughout the montane zone, from Peradeniya up to 6,000 feet. Recorded from India also. A flattish species, with prominent medio-longitudinal and two transverse carinae.

116. **Lecanium antidesmae** Green

Green, *Ind. Mus. Notes*, IV, No. 1, 1896

Green, *Cocc. Ceyl.*, III, p. 209, Pl. LXXIII, 1904

On foliage of *Antidesma bunius*. Pundaluoya: Kandy. Distinguished by a submarginal series of glandular areas, from each of which springs a conspicuous white filament.

117. **Lecanium acutissimum** Green

Green, *Ind. Mus. Notes*, IV, no. 1, 1896

Green, *Cocc. Ceyl.*, III, p. 218, Pl. LXXVIII, 1904

On *Cocos nucifera* and various palms; on *Musa*, *Piper*, *Nephelium* and many other trees, shrubs and plants. Widely distributed throughout the Island. Recorded from India and recently received from Mauritius. A curiously narrow species, acutely pointed at both extremities; with reduced limbs and antennae; of the form and size of a caraway seed.

118. **Lecanium arundinariae** Green

Green, *Cocc. Ceyl.*, III, p. 220, Pl. LXXIX, 1904

On *Arundinaria* sp. Pundaluoya. Not known elsewhere. Of similar form to the preceding species; but with well developed legs and antennae.

119. **Lecanium marsupiale** Green

Green, *Cocc. Ceyl.*, III, p. 212, Pl. LXXV, 1904

On upper surface of leaves of *Piper nigrum* and other species of Pepper; on *Pothos scandens* and occasionally on *Anona* spp. Peradeniya and Matale. Recorded also from India, Malaya and Siam. A broad and very flat species. On the venter is a conspicuous cavity on each side of the abdomen, in which the young larvae are retained for a short time after birth. The male puparia (see figs. 8 and 9) have a character peculiar to this species.

120. **Lecanium psidii** Green

Green, *Cocc. Ceyl.*, III, p. 225, Pl. LXXXII, 1904

On leaves and small branches of *Psidium guyava*, *Mangifera*, *Artocarpus integrifolia*, *Eugenia* spp., and *Myristica moschata*. Always attended by ants. Throughout the lower montane zone. Recorded from Ceylon only.

121. **Lecanium caudatum** Green

Green, *Cocc. Ceyl.*, III, p. 223, Pl. LXXXI, 1904

On the upper surface of foliage of *Passiflora*, *Coffea arabica*, *Meme-cylon umbellatum* and *Pavetta* sp. Pundaluoya: Kandy. Recorded from Ceylon only. The specific name is suggested by the presence (in

the living insect) of several long, slender, waxy filaments proceeding from the posterior extremity.

**122. *Lecanium fusiforme* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1020, fig. 21, 1922

On the upper surface of foliage of an undetermined shrub. Ambalangoda. Recorded from Ceylon only. Characterized by the production of the two extremities into beak-like points.

**123. *Lecanium desolatum* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1020, fig. 20, 1922

Occurring singly, on undersurface of leaves of *Ficus gibbosa*. Peradeniya. Recorded from Ceylon only.

**124. *Lecanium illuppalamae* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1021, fig. 22, 1922

On twigs of an undetermined tree. Maha Illuppalama. Recorded only from Ceylon.

**125. *Lecanium ixorae* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1022, fig. 23, 1922

On *Ixora coccinea*. Heneratgoda. Recorded from Ceylon only. The structural characters are very similar to those *L. psidii*; but *ixorae* is smaller, flatter and a less densely chitinous insect. These differences are not due to immaturity, as the bodies contained ova.

**126. *Lecanium latioperculatum* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1022, fig. 24, 1922

On the smaller branches of an undetermined shrub. Peradeniya; Batticaloa. Received also from India, on *Mangifera indica* and *Anacardium occidentale*. The species is distinguished by the unusual breadth of the anal operculum.

**127. *Lecanium tripartitum* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1025, fig. 27, 1922

On foliage of *Calophyllum walkeri*. Namunakuli Hill. Recorded from Ceylon only.

128. *Lecanium (Saissetia) oleae* (Bernard)

*Chermes oleae*, Bernard, *Mem. d'Hist. Nat. Acad.*, 1782

*Lecanium oleae*, Green, *Cocc. Ceyl.*, III, p. 227, Pl. LXXXIII, 1904

A very widely distributed species, found throughout the tropical and subtropical regions and (frequently as a pest) in the southern countries of Europe. It is comparatively a scarce species in Ceylon, where it has been observed (usually singly) upon *Thespesia populnea*, *Antidesma bunius*, *Grewia orientalis* and *Duranta plumieri*. Its relative local scarcity suggests that it may be kept in check by local parasites.

129. *Lecanium (Saissetia) nigrum* Nietner

Nietner, *Enemies of the Coffee Tree*, p. 9, 1861

Green, *Cocc. Ceyl.*, III, p. 229, Pl. LXXXIV, 1904

Almost as widely distributed as the previous species. In Ceylon it occurs commonly, in injurious numbers, on *Hibiscus rosa-sinensis*, *Croton tiglium* and various species of *Anona*. It occurs also on a large number of other plants, including *Coffea*, *Cinchona*, *Manihot* and *Hevea*.

130. *Lecanium (Saissetia) hemisphaericum* Targ.

Targioni-Tozzetti, *Studi Sulle Cocciniglie*, 1867

*Lecanium coffeae*, Signoret, *Ann. Soc. Ent. Fr.*, (5), III, p. 435, 1873

*Lecanium hemisphaericum*, Green, *Cocc. Ceyl.*, III, p. 232, Pl. LXXXV, 1904

This insect, formerly known as the 'Brown Coffee Bug', was considered to be the most serious pest of the Coffee tree in Ceylon, until the ravages of the 'Green Coffee Bug' *Lecanium viride* completely eclipsed the work of the earlier species. The species is as omnivorous as it is cosmopolitan. It has been recorded from almost every country, in both Hemispheres; but, in the more northern regions, it is found only in glass-houses and cannot survive a European winter.

131. *Lecanium (Platysaissetia) crustuliforme* (Green)

*Neolecanium crustuliforme*, Green, *Cocc. Ceyl.*, IV, p. 252, Pl. XCIV, 1909

On the branches of an undetermined tree. Chilaw. Recorded from Ceylon only. The specific name is suggested by the pie-like contour which is particularly noticeable in a side view of the insect.

**132. *Lecanium litseae* Ruthfd.**

Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, p. 111, 1915

On *Litsea longifolia*. Peradeniya. I have not seen examples of this insect. The author remarks that "It resembles somewhat *L. piperis*, but is much darker in colour and eyes are not visible".

**133. *Paralecanium expansum* (Green)**

*Lecanium expansum*, Green, *Ind. Mus. Notes*, IV, 1, p. 8, 1896. Green, *Cocc. Ceyl.* III, p. 235, Pl. LXXXVI, 1904

On upper surface of leaves of *Dalbergia* and *Litsea* spp. Pundaluoya. Recorded also from India and Australia. A large, flat species, readily separable from all other species of the genus (except *mancum*) by the complete absence of legs.

**134. *Paralecanium expansum-quadratum* (Green)**

Green, *Cocc. Ceyl.*, III, p. 236, Pl. LXXXVI, fig. 19, 1904

On foliage of the 'Nutmeg' (*Myristica fragrans*). Balangoda. Differs from the type in a reduction of the antennae and the quadrate form of the anal operculum.

**135. *Paralecanium mancum* (Green)**

*Lecanium mancum*, Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1023, fig. 25, 1922

On foliage of *Calophyllum walkeri*. Namunakula Hill, Badulla. Recorded from Ceylon only. The complete absence of legs separates this from all its allies, except *expansum*, from which it may be distinguished by its smaller size and subtriangular form.

**136. *Paralecanium marginatum* (Green)**

*Lecanium marginatum*, Green, *Ind. Mus. Notes*, IV, 1, p. 8, 1896  
Green, *Cocc. Ceyl.*, III, p. 239, Pl. LXXXVII, 1904

On upper surface of leaves of *Psychotria thwaitesii*. Pundaluoya. Recorded from Ceylon only.

**137. *Paralecanium geometricum* (Green)**

*Lecanium geometricum*, Green, *Ind. Mus. Notes*, IV, 1, p. 8, 1896  
Green, *Cocc. Ceyl.*, III, p. 239, Pl. LXXXVIII, 1904

On upper surface of leaves of *Glycosmis pentaphylla* Pundaluoya. Recorded from Ceylon only. Recognizable by the geometrical pattern of the depressed areas on the dorsum.



138. **Paralecanium calophylli** (Green)

*Lecanium calophylli*, Green, *Cocc. Ceyl.*, III, p. 240, Pl. LXXXIX, 1904

On foliage of *Calophyllum* sp. Nuwara Eliya. Recorded from Ceylon only.

139. **Paralecanium peradeniyense** (Green)

*Lecanium peradeniyense*, Green, *Cocc. Ceyl.*, III, p. 241, Pl. XC, 1904

On upper surface of leaves of *Piper nigrum* and *Smilax ovalifolia*. Peradeniya: Heneratgoda. Ceylon only.

140. **Paralecanium zonatum** (Green)

*Lecanium zonatum*, Green, *Cocc. Ceyl.*, III, p. 245, Pl. XCII, 1904

On undersurface of leaves of *Garcinia spicata*. Peradeniya. Recorded from Ceylon only. Recognizable (in life) by concentric zones of different tints.

141. **Paralecanium planum** (Green)

*Lecanium planum*, Green, *Ind. Mus. Notes*, 30, 1, p. 8, 1896

Green, *Cocc. Ceyl.*, III, p. 243, Pl. XCI, 1904

On upper surface of leaves of *Nothopegia colebrookiana*. Pundaluoya. Recorded from Ceylon only.

142. **Paralecanium maritimum** (Green)

*Lecanium planum* var. *maritimum*, Green, *Ind. Mus. Notes*, IV, 1, p. 8, 1896

*Lecanium maritimum*, Green, *Cocc. Ceyl.*, III, p. 246, Pl. XCIII

On both surfaces of leaves of *Carissa* sp. and *Ixora coccinea*. Colombo: Bentota. On the seashore, almost within reach of the surf. Received also from Singapore and recorded from India. This species was, at first, believed to be a variety of *planum*; but subsequent study has shown it to be distinct. It may be distinguished, superficially, by its shiny surface, which has the appearance of being coated with varnish. *L. planum* has a dull surface.

143. **Paralecanium limbatum** (Green)

*Lecanium limbatum*, Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1023, 1922

On foliage of *Ixora coccinea*. Batticaloa. Recorded from Ceylon only.

144. **Paralecanium trifasciatum** (Green)

*Lecanium trifasciatum*, Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1024, fig. 26, 1922

On foliage of *Hemicyclea lanceolata*. Batticaloa. Recorded from Ceylon only. This species may be recognized by the three broad, reddish-brown, transverse bands across the dorsum.

145. **Ctenochiton cinnamomi** Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1030, fig. 32, 1922

On *Cinnamomum* sp. Colombo. Recorded from Ceylon only. Superficially resembling *Lecanium oleae*, but without conspicuous carinae.

146. **Ctenochiton fryeri** Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1031, fig. 33, 1922

On an undetermined tree. Vavuniya.

147. **Ctenochiton olivaceum** Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1032, fig. 34, 1922

On undersurface of leaf of *Pterospermum suberifolium*. Matale.

148. **Neolecanium cinnamomi** Ruthfd.

Rutherford, *Bull. Entom. Research*, V, 3, p. 265, 1914

"On bark and branches of *Cinnamomum*." I have not seen Rutherford's types of this species. The author remarks that the insect "is obviously closely related to Green's *Neolecanium crustuliforme*"; but I think it would more probably come under the genus *Ctenochiton* and may, indeed, be identical with my *Cten. cinnamomi*.

149. **Neolecanium pseudoleae** Ruthfd.

Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, 1, p. 112, 1915

"On branches of *Cinnamon*, Peradeniya, July". I have not seen examples of this species. From the description given by the author, I can see no reason why it should not be included in the genus *Saissetia*.

**150. *Protopulvinaria longivalvata* Green**

Green, *Cocc. Ceyl.*, IV, p. 254, Pl. XCV, 1909

On leaves of *Piper nigrum*. Heneratgoda. Also on *Piper* sp. and *Loranthus* sp., at Peradeniya. Ceylon only.

**151. *Pulvinaria thespesiae* Green**

Green, *Cocc. Ceyl.*, IV, p. 259, Pl. XCVII, 1909

On *Thespesia populnea*. Jaffna. Rutherford has recorded the species from Kaduganawa, on *Croton tiglium*. Recorded also from India and Formosa. Very near *P. maxima* Green, from Java, of which it may possibly be regarded as a variety. In the original description (loc. cit.) it is stated that the two forms differ in the relative proportions "of the 2nd and 3rd antennal joints". This was a clerical error for "3rd and 4th joints"; the 3rd joint being more than three times the length of the 4th. A minor distinction is the apparent absence (in *thespesiae*) of the large dermal cells which are a conspicuous feature of typical *maxima*.

**152. *Pulvinaria tessellata* Green**

Green, *Ind. Mus. Notes*, IV, 1, p. 8, 1896

Green, *Cocc. Ceyl.*, IV, p. 260, Pl. XCVIII, 1909

On undersurface of leaves of *Ophiorrhiza pectinata*, Pundaluoya; on *Strobilanthes*; Nuwara Eliya, and on an undetermined plant, Yatiyantota. Recorded from Ceylon only. The tessellated pattern, noticeable on the living insect, is only faintly indicated in examples mounted in canada balsam. The elongate anal operculum, which resembles that found in the genus *Protopulvinaria*, is a distinctive character of this species.

**153. *Pulvinaria cellulosa* Green**

Green, *Cocc. Ceyl.*, IV, p. 262, Pl. XCIX, 1909

On *Citrus* spp. Pundaluoya. It has been suggested that my *P. cellulosa* is identical with Cockerell's *polygonata*; but comparison with typical examples of the latter species, shows that, in *cellulosa*, the marginal cilia are finer and set more closely together and that the stigmatic spines are more numerous.

**154. *Pulvinaria psidii* Mask.**

Maskell, *Trans. N. Z. Inst.*, XXV, p. 223, 1892

Green, *Cocc. Ceyl.*, IV, p. 264, Pl. C, 1909

On leaves, young branches and fruits of numerous plants, including Tea, Coffee, *Cinchona* and the various species of *Citrus*. A serious pest: sometimes massed in such numbers as to hide the green parts of the plant. Occurring throughout the Is'and. Elsewhere recorded from New Zealand, the Hawaiian Islands, Formosa, China and India. *P. cupaniae* Ckll., (from Jamaica) and *P. ficus* Hemp., (from Brasil) are doubtfully distinct from *psidii*.

**155. *Pulvinaria ixorae* Green**

Green, *Cocc. Ceyl.*, IV, p. 266, Pl. CI, figs. 1-3, 1909

On *Ixora coccinea*. Batticaloa. Not recorded elsewhere. Readily distinguishable from other Ceylon species by the unusual length of the marginal setae.

**156. *Pulvinaria tomentosa* Green**

Green, *Ind. Mus. Notes*, IV, p. 8, 1896

Green, *Cocc. Ceyl.*, IV, p. 267, Pl. CI, figs. 4-9, 1909

On leaves and small branches of an undetermined shrub. Not recorded elsewhere.

**157. *Ceronema koebeli* Green**

Green, *Cocc. Ceyl.*, IV, p. 256, Pl. XCVI, 1909

On branches of *Sapium sebiferum*. Kandy. Rutherford found the same species on *Pithecolobium saman*, at Peradeniya. It has been recorded also from India, on *Caesalpinia coriaria*. The large fluted ovisac, which eventually conceals all but a small area of the dorsum of the female, is a conspicuous feature of the species.

**158. *Ceronema fryeri* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1028, fig. 30, 1922

On an unidentified shrub. Maha Illuppalama. Recorded from Ceylon only. Well characterized by the presence of two dense, waxy bands, arising, on each side, from the stigmatic areas and extending upwards over the dorsum. Also by a pair (possibly more) of long,

stout, curling, white processes extending backwards from near the hinder extremity of the insect.

159. **Ceronema iceryoides** Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1029, fig. 31, 1922

On an undetermined plant. Puttalam. Recorded from Ceylon only. This insect superficially resembles *Icerya aegyptiaca* so closely that the single example, upon which the species was founded, was put aside as a specimen of the *Icerya*. It was only after denudation in potassium hydrate, that its true character was revealed.

160. **Ceroplastes ceriferus** Anders.

Anderson, *Mon. Cocci. Ceriferi*, 1871

Green, *Cocc. Ceyl.*, IV, p. 270, Pl. CII, 1909

On stems and branches of various plants, including tea, *Morus indica* and *Ficus* spp. Common throughout the Island. Elsewhere recorded from tropical regions in both hemispheres; India, Australia, Japan, Hawaiian Islands, Chili, Mexico, and the West Indies. This is the largest of our local species of *Ceroplastes* and is characterized by a very thick covering of dense wax. The denuded insect exhibits a long, densely sclerose, cylindrical anal process, which sufficiently distinguishes it from the following species.

161. **Ceroplastes pseudoceriferus** Green

Green, *Stylops*, IV, 8, p. 181, Aug., 1935

On an unidentified plant. Jaffna. Recorded also from India, on *Azadirachta indica* and *Diospyros* sp. Superficially resembling the preceding species; but not so highly convex and with a depressed marginal border. The denuded insect differs in the form of the anal process, which is shorter, stouter and conical.

162. **Ceroplastes rubens** Mask.

Maskell, *Trans. N. Z. Inst.*, XXV, p. 214, 1892

Green, *Cocc. Ceyl.*, IV, p. 273, Pl. CIII, 1909

On the foliage of tea, mango, avocado pear, *Cycas revoluta*, *Garcinia spicata* and many other plants. Throughout the lower montane zone and at Batticaloa. Originally described from Australia, on *Mangifera indica* and *Ficus* sp. Recorded also from India, Hongkong, Formosa and the Hawaiian Islands. Recognizable by the red colour of the waxy test, which varies from deep red to pale rose.

163. *Ceroplastes actiniformis* Green

Green, *Ind. Mus. Notes*, IV, p. 8, 1896

Green, *Cocc. Ceyl.*, IV, p. 275, Pl. CIV, 1909

On the fronds of coconut and other palms: also on foliage of *Canna* and *Sapium sebiferum*. Pundaluoya: Kandy: Colombo. Recorded also from India and Java. There is a possibility that this may be a large, racial form of *C. rusci* L.

164. *Ceroplastes floridensis* Comst.

Comstock, *Rep. U. S. Dep. Ag.* 1880, p. 331, pub. 1881

Green, *Cocc. Ceyl.*, IV, p. 277, Pl. CV, 1909

In Ceylon, on *Psidium guajava*, Tea, *Mangifera* and numerous other plants and shrubs. Widely distributed throughout the Island. Elsewhere recorded from the United States, West Indies, Hawaiian Islands, India, Brasil, Japan, Australia and Java. I have recently received the species from Mauritius, which was the country of origin of Signoret's, *Ceroplastes vinsonii*. Indeed, I have a strong suspicion that *floridensis* and *vinsonii* may be identical. On enquiry at the Vienna Museum (which acquired Signoret's collection) I learn that the types of *vinsonii* cannot be found. Under these circumstances, we must retain Comstock's name for the species. This pretty little insect may be recognized by its resemblance (in miniature) to a cowrie shell.

165. *Vinsonia stellifera* (Westw.)

*Coccus stellifera*, Westwood, *Proc. Ent. Soc. Lond.*, pp. 3, 14, 1871

*Vinsonia pulchella*, Signoret, *Ann. Soc. Ent. Fr.*, (5), II, p. 34, 1874

*Vinsonia stellifera*, Green, *Cocc. Ceyl.*, IV, p. 280, Pl. CVI, 1909

On foliage of Coconut, Mango, *Garcinia spicata*, *Antidesma bunius*, *Alstonia scholaris* and many other trees. Widely distributed throughout the tropical regions. The genus is closely allied to *Ceroplastes*, from which it differs solely in the possession of radiating waxy processes, giving this insect a resemblance to a miniature star-fish.

166. *Ceroplastodes cajani* (Mask.)

*Eriochiton cajani*, Maskell, *Ind. Mus. Notes*, II, p. 61, 1891

*Ceroplastodes cajani*, Green, *Cocc. Ceyl.*, IV, p. 285, Pl. CVIII, 1909

On stems of *Abrus precatorius*, *Atylosia candollei*, *Coleus* sp. and *Ipomea* sp. Chilaw: Hakgala: Jaffna. Recorded also from India, on tea, *Ziziphus jujuba* and *Ocimum sanctum*.

**167. Ceroplastodes chiton Green**

Green, *Cocc. Ceyl.*, IV, p. 287, Pl. CIX, 1909

On the stems and small branches of *Cassia* sp. Maha Illuppalama, N.-C. P. Recorded also from India (on *Cajanus* and *Solanum*); from the Andaman Islands (on *Canavalia*); from Siam (on *Bauhinia*); and from Formosa (on *Ficus*). Readily distinguishable from *cajani* by its greater size and by the symmetrically disposed plates on the test of the female insect.

**168. Ceroplastodes virescens Green**

Green, *Cocc. Ceyl.*, IV, p. 288, Pl. CX, 1909

On terminal shoots of *Theobroma cacao*. Matale. Doubtfully recorded from Singapore, on *Gordonia* sp. Distinguishable from the two preceding species by the greenish colour of the test, and by the multiplication of the marginal spines.

**169. Inglisia chelonoides Green**

Green, *Cocc. Ceyl.*, IV, p. 283, Pl. CVII, 1909

On *Gelonium lanceolatum*. Pundaluoya. Also on *Pithecolobium dulce*. Colombo. Recorded also from India, on *Parkinsonia aculeata*. In my original description I wrote "In form and colour it bears a remarkable resemblance to a rose thorn, and it is probable that its proper habitat may be a thorny plant". Its subsequent discovery on *Parkinsonia* would seem to corroborate this theory.

**170. Cardiococcus castilloae (Green)**

*Inglisia castilloae*, Green, *Journ. Econ. Biol.*, VI, 2, p. 29, Pl. I, 1911

On *Castilloa elastica*, *Grewia microcos*, *Adenochlaena zeylanica* and several other plants, including the tea plant. Recorded from Ceylon only. The species of *Cardiococcus* are distinguished from *Inglisia* by the bilaterally bivalvate character of the test. This particular species suddenly came into prominence in the Koslanda district, where it caused some alarm as a pest of *Castilloa* rubber, the branches of which became thickly encrusted by the insects. I have not heard of its occurrence in other localities and, with the practical abandonment of the cultivation of *Castilloa*, the insect attracted little further attention.

171. **Tectopulvinaria farinosa** (Green)

*Exaeretopus farinosus*, Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1027, fig. 29, 1922

On the young stems and foliage of *Psychotria bisulcata*. Namunakula Hill, Badulla. Recorded from Ceylon only. This species was originally assigned, somewhat doubtfully, to the genus *Exaeretopus*, on account of the pseudo-articulation of the tarsi. I have since had an opportunity of examining the Brazilian species—*Tectopulvinaria albata* Hemp., which has the same peculiarity and, moreover, conforms more closely to the present species in other characters.

172. **Lecanopsis ceylonica** Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1026, fig. 28, 1922

The single example, upon which the species was based, was found at the base of a grass plant, below a large stone, at Pattipola. The same species has recently been recorded from India.

173. **Aclerda distorta** Green

Green, *Cocc. Ceyl.*, IV, p. 290, Pl. CXI, 1909

Concealed beneath the leaf-sheaths of *Arundinaria* and *Bambusa* spp. Pundaluoya: Udagama: Yatiyantota. Recorded from Ceylon only. A character distinguishing this from other known species of the genus is the distortion of the terminal segments of the body.

## Subfamily CONCHASPINAE

174. **Conchaspis socialis** Green

Green, *Cocc. Ceyl.*, I, p. 20, Pl. III, 1896

Discovered, by the late Mr. John Pole, on an unidentified shrub, at Tangalla. Not recorded elsewhere. The small females construct relatively large scales on the smaller branches, which provide shelter, not only for themselves and their ova, but also for the male puparia.

## Subfamily DIASPINAE

175. **Diaspis pentagona** Targ.

Targioni, *Revista di Bacchicoltura*, No. 11, 1885

*Diaspis amygdali*, Trion, *Rep. on Fungous Pests*, p. 89, 1889. Green, *Cocc. Ceyl.*, I, p. 87, Pl. XXIV, 1896

In Ceylon, on a large number of wild and cultivated plants of various genera and orders. It is sometimes a serious pest of cultivated geraniums in upcountry gardens. Abroad, the species is a recognized pest



of stone-fruits in all the warmer regions of the World. In Europe, it is chiefly confined to plant houses. The scales of the female are often concealed beneath superficial fragments of bark or by the tomentum of the plant; but the snowy white male puparia, which are usually thickly clustered together, are very conspicuous.

**176. *Diaspis fagraeae* Green**

Green, *Cocc. Ceyl.*, I, p. 91, Pl. XXV, 1896

Clustered on the flower buds of *Fagraea zeylanica*. Haldummulla. Recorded from Ceylon only. Superficially resembling the previous species; but differing in the size and form of the median lobes.

**177. *Diaspis major* (Ckll.)**

*Chionaspis major*, Cockerell, *Ent. News*, V, p. 43, 1894

*Aulacaspis flacourtiæ*, Rutherford, *Bull. Ent. Research*, V, 3, p. 259, 1914

On the stems of *Flacourtia ramontchii*. Peradeniya. Originally described from Antigua, W.I., on *Heliotropium*. Since recorded from Cuba, the Seychelles, Mauritius and Formosa. In Ceylon, the insects often induce large swellings of the ligneous tissues sublying the point of attack.

**178. *Diaspis barberi* Green**

Green, *Mem. Dep. Ag. Ind.*, II, 2, p. 35, Pl. IV, fig. 19, 1908

On *Loranthus* sp. and *Myristica fragrans*. Peradeniya. Recorded also from India, on *Loranthus*.

**179. *Diaspis myristicae* (Ruthfd.)**

*Aulacaspis myristicae*, Rutherford, *Bull. Ent. Research*, V, 3, p. 260, 1914

"On midrib of *Myristica laurifolia* (Wild Nutmeg)". Rutherford compares this species with *Diasp. fagraeae*, and *D. barberi*, pointing out certain differences from those species. I have not seen Rutherford's types of this species.

**180. *Diaspis uncinati* (Ruthfd.)**

*Aulacaspis uncinati*, Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, 1, p. 117, 1915

"Underneath the leaf-sheaths of *Panicum uncinatum*. Peradeniya." I have not examined types of this species. No species of *Diaspis* (or of *Aulacaspis*) has hitherto been recorded from *Panicum* or from any other grass.

**181. *Diaspis antiquorum* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1011, fig. 8, 1922

On the fleshy branches of *Euphorbia antiquorum*, associated with *Parlatoria pseudaspidotus* Lindgr. Elephant Pass; Nalanda. Recorded from Ceylon only.

**182. *Diaspis heneratgoda* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1012, fig. 10, 1922

On foliage of undetermined tree. Heneratgoda. Recorded from Ceylon only.

**183. *Diaspis mihiriya* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1014, fig. 13, 1922

On foliage of *Dichopsis grandis*. Bogawantalawa. Recorded from Ceylon only.

**184. *Diaspis grandilobis* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1015, fig. 14, 1922

On the smaller branches of *Diospyros thwaitesii*. Peradeniya. Recorded from Ceylon only.

**185. *Diaspis boisduvalii* Sign.**

Signoret, *Ann. Soc. Ent. France*, (4), IX, p. 432, 1869

On the foliage of various cultivated Orchids. Peradeniya: Maskeliya. Elsewhere, recorded from nearly every tropical and subtropical country: also (under glass) in Europe. This species is peculiar in the possession of a small fleshy tubercle on each side of the cephalo-thorax.

**186. *Aulacaspis loranthi* (Green)**

*Diaspis loranthi*, Green, *J. Bombay Nat. Hist. Soc.*, XIII, 2, p. 254, Pl. F, figs. 25, 26, 1900

On undersurface of leaves *Loranthus tomentosus*. Pundaluoya: Bandarawela. Recorded also from India, on the same plant.

187. *Aulacaspis bambusae* (Green)

*Diaspis bambusae*, Green, *J. Bombay Nat. Hist. Soc.*, xxviii, 4, p. 1012, fig. 9, 1922

On small stems and branches of *Bambusa* sp. Yatiyantota. Recorded from Ceylon only.

188. *Aulacaspis orientalis* (Green)

*Diaspis orientalis*, Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1013, fig. 11, 1922

On foliage *Sapindus* sp. and various undetermined trees. Sigiriya: Maha Illuppalama. Recorded also from India, on *Hemigyrosa* sp.

189. *Aulacaspis phoenicis* (Green)

*Diaspis phoenicis*, Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1014, fig. 12, 1922

On upper surface of foliage of *Phoenix zeylanica*. Maha Illuppalama. Recorded from Ceylon only.

The preceding four species are referred to the genus *Aulacaspis* Ckll. as having the characters of *Diaspis rosae* Bouché, which was the particular species selected, by Cockerell, as the type of his new genus. I do not agree that *pentagona* (which was cited by that author as a member of the same genus), is in agreement with *rosae*, in respect to these special characters.

190. *Chionaspis graminis* Green

Green, *Ind. Mus. Notes*, IV, 1, p. 2, 1896. *Cocc. Ceyl.*, II, p. 123, Pl. XXXVIII, 1899

On upper surface of foliage of *Andropogon nardus* (Mana Grass). Common wherever this particular grass occurs. The typical form is recorded from Ceylon only. The snowy white puparia are rendered more conspicuous by a purple discoloration of the tissue of the leaf immediately surrounding them.

191. *Chionaspis graminis-divergens* Green

Green, *Cocc. Ceyl.*, II, p. 123, Pl. XXXVIII, fig. 9, 1899

On same host-plant. Recorded also from India and Northern Australia. Differing from the type in the blunter pygidium coupled with widely divergent median lobes.

**192. *Chionaspis elongata* Green**

Green, *Ind. Mus. Notes*, IV, 1, p. 4, 1896. *Cocc. Ceyl.*, II, p. 125, Pl. XXXIX, 1899

On leaves of a bamboo. Pundaluoya: Nuwara Eliya. Recorded also from India and Formosa. An elongate and narrow species.

**193. *Chionaspis arundinariae* Green**

Green, *Cocc. Ceyl.*, II, p. 127, Pl. XL, 1899

On undersurface of *Arundinaria* sp. Kelani Valley: Udagama. Recorded from Ceylon only.

**194. *Chionaspis minuta* Green**

Green, *Ind. Mus. Notes*, IV, 1, p. 3, 1896. *Cocc. Ceyl.*, II, p. 128, Pl. XLI, 1899

On undersurface of leaves of *Tetranthera* sp. Pundaluoya. Recorded from India also. The scales occur in immense numbers on the leaves; but, from their minute size, are very inconspicuous.

**195. *Chionaspis herbae* Green**

Green, *Cocc. Ceyl.*, II, p. 132, Pl. XLIII, 1899

On the stems and foliage of various grasses. Pundaluoya. Recorded also from India, Algeria and Palestine. I have a suspicion that several closely allied species may be included under the same name.

**196. *Chionaspis polygoni* Green**

Green, *Cocc. Ceyl.*, II, p. 134, Pl. XLIV, 1899

On stems of *Polygonum chinense*. Pundaluoya. Recorded from Ceylon only.

**197. *Chionaspis acuminata* Green**

Green, *Ind. Mus. Notes*, IV, 1, p. 3, 1896. *Cocc. Ceyl.*, II, p. 136, Pl. XLV, 1899

On leaves of *Ardisia* sp. and on an unidentified shrub. Pundaluoya. Recorded from Ceylon only. The scale is elongate and narrow, with a well-defined median longitudinal ridge. In the typical species the scale is of a pale brownish ochreous colour.

198. **Chionaspis acuminata-atricolor** Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1017, 1922

On foliage of *Carissa* sp. Kandy: Maha Illuppalama. This variety has been recorded also from India, on *Carissa*, *Tamarindus* and *Ficus retusa*. Differing from the typical species in the constant deep brown colour of the scales.

199. **Chionaspis elaeagni** Green

Green, *Ind. Mus. Notes*, IV, 1, p. 3, 1896

On the undersurface of leaves of *Elaeagnus latifolia*. Pundaluoya. Recorded from Ceylon only. The female insects are completely concealed beneath the stellate scales which cover the undersurface of the leaves of this plant.

200. **Chionaspis vitis** Green

Green, *Ind. Mus. Notes*, IV, p. 3, 1896. *Cocc. Ceyl.*, II, p. 140, Pl. XLVII, 1899

On undersurface of *Vitis lanceolaria* and allied species; also, occasionally, on *Elaeagnus latifolia* and *Loranthus* sp. Pundaluoya: Nuwara Eliya. Recorded also from India, Java, Sumatra and Formosa. The presence of the insects is indicated by extensive yellowing of the foliage.

201. **Chionaspis hedyotidis** Green

Green, *Cocc. Ceyl.*, II, p. 142, Pl. XLVIII, 1899

On the foliage of *Hedyotis auricularia* and allied species. Pundaluoya: Nuwara Eliya. The scale of the female is thin and semitransparent. Recorded also from India, Java and Formosa.

202. **Chionaspis coronifera** Green

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 353, Pl. K, figs. 33, 34, 1905

On leaves of an undetermined tree. Galgamuwa, N.-W. P. Known from Ceylon only.

203. **Chionaspis madiunensis** Zehnt.

Zehntner, *Mede. Proef. Suik.*, Java, (3), No. 6, p. 1, 1899

On *Saccharum arundinaceum*. Peradeniya. Originally described from sugar-cane, in Java. The record, for Ceylon, appears to have been omitted from any of my 'Supplementary Notes' and appears here, for the first time.

204. *Chionaspis subcorticalis* Green<sup>1</sup>

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 351, Pl. K, fig. 31, 1905

Beneath loose bark of *Artocarpus integrifolia*. Peradeniya: Matale. Recorded also from Mauritius and the Seychelles.

205. *Chionaspis gynandropsidis* Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1017, fig. 16, 1922

On stems and branches of *Gynandropsis* sp. and *Solanum*. Peradeniya: Maha Illuppalama. Recorded also from the Seychelles.

206. *Chionaspis malloti* Ruthfd.

Rutherford, *Bull. Entom. Research*, V, 3, p. 263, 1914

"On twigs of *Mallotus philippinensis*, causing slight swellings." I have not seen examples of this species.

207. *Chionaspis litseae* Green

*Chionaspis litseae*, Green, *Cocc. Ceyl.*, II, p. 144, Pl. XLIX, 1899

On leaves of *Litsea zeylanica*. Pundaluoya: Nuwara Eliya. I have a (rather doubtful) record of the species from China. The alteration in the spelling of the specific name, as originally published, is necessitated by the fact that the host-plant is 'Litsea' (not 'Litzea').

208. *Chionaspis varicosa* Green

Green, *Cocc. Ceyl.*, II, p. 146, Pl. L, 1899

On undersurface of leaves of *Gelonium lanceolatum*. Pundaluoya. Recorded also from India (on *Loranthus*) and from Java (on *Piper* sp.).

209. *Chionaspis dilatata* Green

Green, *Cocc. Ceyl.*, II, p. 148, Pl. LI, 1899

Upon the foliage of a large number of plants and trees, including *Mangifera*, *Myristica*, *Hevea* and *Māraṇta*. Pundaluoya and Kandy. Recorded also from India, Java, Reunion Is., Egypt, S. Africa and Australia. Greatly resembling the previous species (*varicosa*), from which it differs in the suppression of the second pair of lateral lobes.

<sup>1</sup> Numbers 204 to 209 fall into Cooley and Cockerell's genus *Phenacaspis*, characterized by having the median lobes (trullae) recessed. But, as the boundaries of this genus are very vague, they are here referred to the older genus—*Chionaspis*.

**210. *Chionaspis strobilanthi* Green**

*Chionaspis strobilanthi*, Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 352, Pl. K, fig. 32, 1905

On *Strobilanthes* sp. Haputale. Recorded from Ceylon only. (The termination of the specific name has been altered to agree with the name of the host plant.)

**211. *Chionaspis megaloba* Green**

Green, *Cocc. Ceyl.*, II, p. 149, Pl. LII, 1899

On leaves of *Psidium* sp., Kandy; on *Tetranthera*, Hakgala; and *Actinodaphne*, Pedrotalagala. Recorded also from India, on *Zizyphus jujuba*.

**212. *Chionaspis tenera* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1019, fig. 18, 1922

On foliage of an undetermined shrub. Maha Iluppalama. Recorded from Ceylon only.

**213. *Parachionaspis galliformens* (Green)**

*Chionaspis galliformens*, Green, *Cocc. Ceyl.*, II, p. 158, Pl. LXI, 1899

*Parachionaspis galliformens*, MacGillivray, *The Coccidae*, p. 354, 1921

The female insects are concealed within gall-like protuberances on the young stems, petioles and midrib of leaves of *Hedyotis lessertiana*. Kalutara. Recorded from Ceylon only. A very abnormal species referred, by MacGillivray, to his new genus, *Parachionaspis*.

**214. *Nudachaspis fodiens* (Green)**

*Chionaspis fodiens*, Green, *Cocc. Ceyl.*, II, p. 155, Pl. LV, 1889

*Nudachaspis fodiens*, MacGillivray, *The Coccidae*, p. 365, 1921

Insects embedded in the bark and leaves of a species of *Loranthus*, without forming any definite cell. Pundaluoya. Recorded from Ceylon only. A very anomalous species, without any of the normal characters of *Chionaspis*. It is doubtful if the scale of the male (shown at fig. 10) is really associated with this insect. I have adopted the generic name assigned to it (loc. cit.) by MacGillivray.

215. *Proceraspis cinnamomi* (Green)

*Chionaspis cinnamomi*, Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 354, Pl. K, figs. 35-36, 1905

*Proceraspis cinnamomi*, MacGillivray, *The Coccidae*, p. 363, 1921

On upper surface of leaves of *Cinnamomum*. Pundaluoya. Recorded from Ceylon only. An elongate form, with the median lobes contiguous, as in the genus *Pinnaspis*, but distinguished by the presence of a pair of claviform paraphyses and absence of perivulvar pores.

216. *Pinnaspis aspidistrae* (Sign.)

*Chionaspis aspidistrae*, Signoret, *Ann. Soc. Ent. Fr.*, (4), IX, p. 443, 1869  
Green, *Cocc. Ceyl.*, II, p. 110, Pl. XXXII, 1899

Common on cultivated ferns and occurring on a large number of other plants. Widely distributed throughout the tropical areas of both Hemispheres, and as a common pest of glass-houses in Europe and other temperate regions.

217. *Pinnaspis theae* (Mask.)

*Chionaspis theae*, Maskell, *Ind. Mus. Notes*, II, No. 1, p. 59, 1891

Green, *Cocc. Ceyl.*, p. 113, Pl. XXXII, 1899

*Chionaspis exercitata*, Green, *Ind. Mus. Notes*, IV, 1, p. 3, 1896

On upper surface of leaves of the tea plant, Pundaluoya; and throughout the tea districts, both here and in India. Apparently not recorded outside the Indian region. A white form occurs at Nuwara Eliya upon *Eurya japonica*,—a plant allied to tea.

218. *Pinnaspis minor* (Mask.)

*Chionaspis minor*, Maskell, *Trans. N. Z. Inst.*, XVII, p. 23, 1884

*Chionaspis albizziae*, Green, *Cocc. Ceyl.*, II, p. 115, Pl. XXXII, 1899

In Ceylon, on the young stems of *Albizzia stipulata*, *Pithecolobium saman* and many other Leguminaceous trees. Also on *Gossipium* and *Ricinus*. Throughout the Island. Recorded also from Australia, Jamaica, Fiji, India, Mauritius, Brazil, Peru and British Guiana, on a great variety of plants.

219. *Pinnaspis mussaendae* (Green)

*Chionaspis aspidistrae* var. *mussaendae*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 2, 1896

*Chionaspis mussaendae*, Green, *Cocc. Ceyl.*, II, p. 117, Pl. XXXV, 1899

On the bark and small branches of *Mussaenda frondosa*. Pundaluoya. Also, occasionally, on *Loranthus* sp. and on *Debregaesia wallichiana*. Doubtfully recorded from Australia and Brazil. A much



larger and more robust species than *aspidistrae*. The scales are usually concealed beneath the tomentum of the plant.

220. ***Pinnaspis rhododendri* (Green)**

*Chionaspis rhododendri*, Green, *Cocc. Ceyl.*, II, p. 119, Pl. XXXVI, 1899

On undersurface of *Rhododendron arboreum*. Nuwara Eliya: Recorded from Ceylon only. The position of the insects can be detected only by small yellow discoloured spots on the upper surface of the leaf. The scales themselves are completely hidden beneath the dense tomentum on the underside of the leaf.

221. ***Pinnaspis scrobicularum* (Green)**

*Chionaspis scrobicularum*, Green, *Cocc. Ceyl.*, II, p. 121, Pl. XXXVII, 1899

The scales are concealed within small pits (scrobiculae) at the base of veins on the undersurface of leaves of *Elacocarpus amoenus*. Pundaluoya. Recorded from Ceylon only.

222. ***Pinnaspis alatae* (Ruthfd.)**

*Hemichionaspis alatae*, Rutherford, *Bull. Ent. Research*, V, 3, p. 262, 1914

"On branches of *Cassia alata*." I have not seen examples of this species.

223. ***Pinnaspis cyanogena* (Ckll.)**

*Hemichionaspis cyanogena*, Cockerell, *The Entomologist*, XXXIV, p. 226, 1901

*Pinnaspis cyanogena*, Green, *Cocc. Ceyl.*, V, p. 464, 1922

Examples, rather doubtfully referred to this species, were found on an undetermined plant, at Trincomali.

224. ***Pinnaspis dracaenae* (Cooley)**

*Hemichionaspis dracaenae*, Cooley, *Spec. Bull. Mass. Exp. Sta.*, p. 57, 1899

*Pinnaspis dracaenae*, Green, *Cocc. Ceyl.*, V, p. 464, 1922

Specimens received from Mr. Hutson, on foliage of Hevea, at Elpitiya, agree closely with Cooley's description and figures of *dracaenae*, from Socotra Island.

225. *Pinnaspis buxi* (Bouché)

*Aspidiotus buxi*, Bouché, *Stett. Ent. Zeit.*, XII, p. 111, 1851

*Mytilaspis pandani*, Comstock, *Rep. U. S. Dep. Ag.*, 1880, p. 324, 1881

This species was found by Mr. Jepson, on fronds of a palm, at Peradeniya. It has been recorded from most tropical countries and occurs (chiefly in glass houses) in Europe.

226. *Tsukushiaspis linearis* (Green)

*Chionaspis linearis*, Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1018, fig. 17, 1922

On the margins of the leaves of a small species of Bamboo. Peradeniya. Recorded from Ceylon only. An elongate and narrow species; difficult to see, in its position on the edge of the leaf. Kuwana erected the genus *Tsukushiaspis* in which the interlobal squamulae are broadly fimbriate or pectinate. My figure of *linearis* (loc. cit) is faulty, in that it omits the fimbriate squamulae, which are actually present between the median pair of lobes (trullae).

227. *Dinaspis flava* (Green)

*Chionaspis flava*, Green, *Cocc. Ceyl.*, II, p. 150, Pl. LIII, 1899

On undersurface of leaves of *Antidesma bunius*. Pundaluoya. Recorded from Ceylon only. Leonardi's genus *Dinaspis* is characterized by the partial or completely indurated thoracic segments and by the absence of perivulvar pores.

228. *Dinaspis permutans* (Green)

*Chionaspis permutans*, Green, *Cocc. Ceyl.*, II, p. 130, Pl. XLII, 1899

On undersurface of leaves of *Antidesma bunius*. Pundaluoya. Recorded also from India, on *Evodia* sp. The induration of the thorax, in this species, is carried to an extreme; the membranous segments of the abdomen being retracted and concealed by the overlapping post-thoracic area. The indurated area assumes a dark purple-brown colour which is visible through the translucent covering scale. A form of the same species occasionally is found occupying small glandular pits at the base of the veins of the leaf. No structural differences are noticeable between the two forms.

229. *Howardia biclavis* (Comst.)

*Chionaspis biclavis*, Comstock, *2nd Report on Scale-Insects*, p. 98, 1893  
*Green, Cocc. Ceyl.*, II, p. 152, Pl. LIV, p. 98, 1899

On the stems and branches of Tea and Cinchona plants, rarely on Coffee. Throughout the montane zone of Ceylon. Comstock called this species the "Mining Scale", in the belief that it burrowed beneath the epidermal layer of the plant. I am of opinion, however, that he was mistaken in this idea, and that what actually happens is that the larval insect works its way beneath the superficial fibres and scaly particles of the bark. During the subsequent secretion of the scale, these loose particles are incorporated into its texture, concealing the scale by harmonizing with its surroundings. Originally described from conservatories in the United States, the species is now known to occur in many tropical countries, including the West Indian Islands, Hawaiian Islands, Japan, Mauritius, and throughout India.

230. *Fiorinia fioriniae* (Targ.)

*Diaspis fioriniae*, Targioni-Tozzetti, *Studi Cocciniglie*, p. 14, 1867  
*Fiorinia fioriniae*, Green, *Cocc. Ceyl.*, I, p. 94, Pl. XXVII, 1896

On foliage of *Camellia*, *Cacao*, *Manihot*, *Persea*, and numerous other trees, shrubs and plants. Throughout the Island. I have records of its occurrence in India, Japan, Australia, Mauritius, the Hawaiian Islands, Brasil and the West Indies. It is also commonly found in European and American glass-houses.

231. *Fiorinia saposmae* Green

Green, *Ind. Mus. Notes*, IV, No. 1, 1896  
*Cocc. Ceyl.*, I, p. 96, Pl. XVII, 1896

On leaves of *Saprosma zeylanicum*. Pundaluoya. Recorded also from Formosa.

232. *Fiorinia geloniae* Green

*Fiorinia saposmae* var. *geloniae*, Green, *J. Bombay Nat. Hist. Soc.*, XIII, No. 2, p. 256, Pl. G., fig. 28, 1900

On foliage of *Gelonium lanceolatum*. Pundaluoya. I found this same species, on an undetermined shrub, at Ootacamund, S. India. At first regarded as a variety of *saposmae*, I now believe it to be a distinct species.

**233. *Fiorinia similis* Green**

Green, *Cocc. Ceyl.*, I, p. 98, Pl. XXVIII, 1896

On leaves of an undetermined shrub. Pundaluoya. Ceylon only.

**234. *Fiorinia scrobicularum* Green**

Green, *Cocc. Ceyl.*, I, p. 100, Pl. XXIX, 1896

The scales are concealed within glandular pits (*Scrobiculae*) at the angles of the veins, on the undersurface of leaves of *Gaertnera koenigii*. Pundaluoya. Recorded from Ceylon only.

**235. *Fiorinia juniperi* Leon.**

Leonardi, *Redia*, III, 1, p. 39, fig. 13, 1905

Green, *Cocc. Ceyl.*, V, p. 494, 1922

On *Juniperus bermudiana*. Kandy. Recorded also from Japan (on *Pinus* sp.), and from Formosa on *Abies* and *Podocarpus*.

**236. *Fiorinia odinae* Leon.**

Leonardi, *Redia*, III, 1, p. 24, fig. 5, 1905

Green, *Cocc. Ceyl.*, V, p. 464, 1922

On foliage of *Odina wodier*. Haragama. Ceylon only.

**237. *Fiorinia bidens* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 351, Pl. J, figs. 29, 30, 1905

On underside of foliage of an undetermined tree. Anuradhapura. Recorded from Ceylon only.

**238. *Fiorinia proboscidea* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XIII, 2, p. 256, Pl. G, figs. 29, 30, 31, 32, 1900

On foliage of *Gelonium lanceolatum*. Pundaluoya. Recorded from Ceylon only.

The species owes its special name to an extraordinary development of the usually small interantennal tubercle, which here is suggestive of the trunk of an elephant.

**239. *Fiorinia theae* Green**

Green, *Ind. Mus. Notes*, V, No. 1, p. 3, Pl. I, figs. 4 to 8, 1900

In Ceylon, on foliage of *Ostodes zeylanicus*. Peradeniya. Recorded also from India, where it is a frequent minor pest of the Tea plant in Assam and the Kangra valley. Distinguished by the prominent spatulate interantennal tubercle.

**240. *Fiorinia kandyensis* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1016, fig. 15, 1922

On the foliage of an undetermined shrub. Kandy. Recorded from Ceylon only.

**241. *Fiorinia rubrolineata* Leon.**

*Trulliflorinia rubrolineata*, Leonardi, *Redia*, III, p. 44, fig. 15, 1906

*Fiorinia rubrolineata*, Green, *Cocc. Ceyl.*, V, p. 464, 1922

On *Murraya exotica*. Peradeniya. Recorded from Ceylon only. The nymphal pellicle of this species has a conspicuous medio-longitudinal red stripe.

**242. *Fiorinia tumida* Leon.**

Leonardi, *Redia*, III, p. 38, fig. 12, 1906

Green, *Cocc. Ceyl.* V, p. 464, 1922

On foliage of *Grewia* sp. Peradeniya. From Ceylon only.

**243. *Adiscoflorinia atalantiae* Leon.**

Leonardi, *Redia*, III, p. 54, fig. 20, 1906

*Fiorinia atalantiae*, Green, *Cocc. Ceyl.*, V, p. 460, 1922

On *Atalantia zeylanica*. Haragama. Ceylon only.

**244. *Adiscoflorinia secreta* (Green)**

*Fiorinia secreta*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 4, 1896

Green, *Cocc. Ceyl.*, I, p. 102, Pl. XXX, 1896

Enclosed in minute, round galls, on the foliage of *Grewia orientalis*. Pundaluoya. Recorded from Ceylon only.

**245. *Lepidosaphes beckii* (Newm.)**

*Coccus beckii*, Newman, *The Entomologist*, IV, p. 217, 1869

*Mytilaspis citricola*, Green, *Cocc. Ceyl.*, I, p. 78, Pl. XX, 1896

On fruit, leaves and stems of various species of *Citrus* and several allied plants. Found practically throughout the World, wherever *Citrus* is cultivated.

**246. *Lepidosaphes gloverii* (Pack.)**

*Coccus gloverii*, Packard, *Guide to the Study of Insects*, Ed. I, p. 527, 1869

*Mytilaspis gloverii*, Green, *Cocc. Ceyl.*, I, p. 83, Pl. XXII, 1896

Habitat and distribution similar to those of the previous species, from which it may be distinguished by the narrower and more elongate scale.

**247. *Lepidosaphes cocculi* (Green)**

*Mytilaspis cocculi*, Green, *Cocc. Ceyl.*, I, p. 81, Pl. XXI, 1896

On undersurface of leaves of *Cocculus macrocarpus*. Kandy. Recorded from Ceylon only.

**248. *Lepidosaphes pallida* (Green)**

*Mytilaspis pallida*, Green, *Ind. Mus. Notes*, IV, No. 1, 1896

*Mytilaspis gloverii* var. *pallida*, Green, *Cocc. Ceyl.*, I, p. 85, Pl. XXIII, 1896

On foliage of various undetermined plants. Pundaluoya: Kandy. Recorded also from India, Japan, Formosa and China.

**249. *Lepidosaphes auriculata* (Green)**

*Mytilaspis auriculata*, Green, *Trans. Linn. Soc. Lond.*, XII, 2, (Zool.), p. 205, Pl. 21, figs. 14-16, 1907

On foliage of *Codiaeum variegatum*. Colombo: Kandy: Pundaluoya. Recorded also from India, the Seychelles, Hawaiian Islands, Singapore, Barbados and Australia,—always on the same host plant. The specific name refers to the presence, on each side of the head, of a more or less pronounced lobe.

**250. *Lepidosaphes lasianthi* (Green)**

*Mytilaspis lasianthi*, Green, *J. Bombay Nat. Hist. Soc.*, XIII, 2, p. 253, Pl. F, fig. 24, 1900

On both surfaces of leaves of *Lasianthus strigosus*. Pundaluoya. Recorded from Ceylon only.

**251. *Lepidosaphes piperis* (Green)**

*Mytilaspis piperis*, Green, *Mem. Dep. Ag. Ind.*, (Entom.), II, 2, Pl. IV, fig. 18, 1908

On *Piper nigrum*. Peradeniya. Recorded also from India.

**252. *Lepidosaphes rubrovittatus* Okll.**

Cockerell, *Pro. Dav. Ac. Sci.*, X, p. 135, 1905  
Green, *Cocc. Ceyl.*, V, p. 463, 1922

On foliage of *Hevea brasiliensis*. Heneratgoda. Originally described from the Philippine Islands, on *Eugenia malaccensis*. I have no record of its occurrence elsewhere.

**253. *Lepidosaphes dilatilobis* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, No. 4, p. 1010, fig. 6, 1922

On undersurface of leaves of *Derris* sp., Sigiriya, and on an undetermined shrub at Ambalangoda. Ceylon only.

**254. *Lepidosaphes vandae* Ruthfd.**

Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, p. 116, 1915

On foliage of an Orchid (*Vanda* sp.) Colombo: Peradeniya. Recorded from Ceylon only.

**255. *Lepidosaphes erythrinae* Ruthfd.**

Rutherford, *Bull. Ent. Research*, V, 3, p. 264, 1914

"On bark of *Erythrina* sp.". Peradeniya. I have seen Rutherford's type; and I have what I believe to be the same species, from *Antidesma*, at Pundaluoya. Recorded from Ceylon only. Rutherford remarks that he knows of "no species of *Lepidosaphes* with which this insect can be confounded". Judging by his description, and by my supposed example from *Antidesma*, the species appears to bear a close resemblance to *hawaiiensis* of Maskell. It has similar large, triangular, mesal trullae, but differs in the absence of the conspicuous clavate paraphyses that are characteristic of *hawaiiensis*.

**256. *Lepidosaphes ambigua* Ruthfd.**

Rutherford, *Bull. Ent. Research*, V, 3, p. 264, 1914

"On twigs of *Mesua ferrea*". Peradeniya. Recorded from Ceylon only. I have not seen Rutherford's types and am unable to recognize the species.

**257. *Ischnaspis longirostris* (Sign.)**

*Mytilaspis longirostris*, Signoret, *Bull. Soc. Ent. Fr.*, (6), ii, p. 35, 1882

*Ischnaspis filiformis*, Douglas, *Ent. Mon. Mag.*, XXIV, p. 21, 1887

In Ceylon, on the foliage of various palms. Elsewhere it has been recorded on various hosts, including *Citrus* and coffee plants, from tropical countries in both Hemispheres and—in plant houses—in England and the United States.

**258. *Aspidiotus orientalis* Newst.**

Newstead, *Ind. Mus. Notes*, III, No. 5, p. 26, Pl. III, fig. 4, 1894

*Aspidiotus osbeckiae*, Green, *Ind. Mus. Notes*, IV, p. 4, 1896

Green, *Cocc. Ceyl.*, I, p. 47, Pl. VII, 1896

A remarkably polyphagous species. My collection contains examples from Ceylon, on *Osbeckia*: from India, on *Ægle*, *Bauhinia*, *Camellia*, *Cassia*, *Cocos*, *Dalbergia*, *Diospyros*, *Eugenia*, *Ficus*, *Limonia*, *Melia*, *Rosa*, *Thea*, *Tamarindus* and *Zizyphus*: from Australia and the Nicobars, on *Musa*: and from Italian Somaliland, on *Ricinus*.

**259. *Aspidiotus destructor* Sign.**

Signoret, *Ann. Soc. Ent. Fr.*, 4, IX, p. 120, 1869

Green, *J. Bombay Nat. Hist. Soc.*, XIII, 1, p. 7, Pl. B, fig. 5, 1899

On tea and various other plants. Pundaluoya. It has been recorded from nearly every tropical country, in both Hemispheres, and is chiefly notorious as a pest of the Coconut Palm.

**260. *Aspidiotus transparens* Green**

Green, *Insect Pests of the Tea Plant*, p. 22, 1890. *J. Bombay Nat. Hist. Soc.*, XIII, 1, p. 6, 1899

(In error), *Aspidiotus lataniae*, Green, *Cocc. Ceyl.*, I, p. 49, Pl. VIII, 1896

On foliage of undetermined tree. Talawakelle. Recorded also from India, on *Piper*; from Fiji, on *Musa*; from Madagascar, on a palm, and from Uganda, on the tea plant. Superficially closely resembling the previous species (*destructor*), from which it may be distinguished by the markedly larger and more prominent trullae.

**261. *Aspidiotus cyanophylli* Sign.**

Signoret, *Ann. Soc. Ent. Fr.*, 4, IX, p. 119, 1869

Green, *Cocc. Ceyl.*, I, p. 51, Pl. IX, 1896

On *Cinchona*, *Cycas* and a palm. Pundaluoya: Kandy. Originally described from Venezuela. Recorded also from India, U. S. America, Sumatra and Japan, on various plants.



**262. *Aspidiotus excisus* Green**

Green, *Cocc. Ceyl.*, I, p. 53, Pl. X, figs. 7-9, 1896

On foliage of *Cyanotis* and *Ipomoea*. Pundaluoya. Takahashi has found, what appears to be the same species, in galls on the foliage of *Clerodendron inerme*, from Formosa. It has also been recorded from Fiji, on *Piper* sp. The species is well characterized by a squarely cut recess, at the extremity of the pygidium, in which the mesal trullae are sunk.

**263. *Aspidiotus cocotiphagus* Marl.**

Marlatt, *Bull. U. S. Bur. Ent.*, E.S. 16, pt. II, p. 14, figs. 1-2, 1908

My only record, for Ceylon, is from a single specimen collected by Dr. Bodenheimer on (?) Mahogany, at Jaffna. The species is more particularly a pest of the Coconut Palm, and has been recorded from Florida, Cuba and the Andaman Islands. The insect is characterized by a sclerous thickening of the thoracic area, with the pygidium retracted—as in *aurantii*.

**264. *Aspidiotus lataniae* Sign.**

Signoret, *Ann. Soc. Ent. Fr.*, 4, IX, p. 124, 1869

*Aspidiotus cydoniae*, Green, *Cocc. Ceyl.*, I, p. 62, Pl. XIV, 1896

? Comstock, *Rep. U. S. Dep. Ag.*, p. 295, 1881

In Ceylon on various palms, *Grevillea*, *Citrus*, etc. Recorded also from India, Australia, Seychelles, Egypt, the Belgium Congo, Uganda, Rhodesia, Algeria, Mauritius, Madeira, Malta and the Channel Islands.

**265. *Aspidiotus palmae* Morg. & Ckll.**

Cockerell and Morgan, *Ent. Mon. Mag.*, XXIX, pp. 39, 40, 1893

My only record from Ceylon is from examples collected by Mr. F. P. Jepson, on *Musa*, at Peradeniya. It has a wide distribution elsewhere, having been recorded from the West Indies, British Guiana, Brasil, Java, Sumatra and the Fiji Islands. It has occasionally occurred in British conservatories.

**266. *Aspidiotus calophylli* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1008, fig. 2, 1922

On foliage of *Calophyllum walkeri*. Namunakuli Hill, Badulla. Recorded also from India. The female insect has a characteristic turbinate form.

**267. *Aspidiotus (Aonidiella) pothi* Ruthfd.**

Rutherford, *Bull. Ent. Research*, V, 3, p. 262, 1914

"On *Pothos scandens*, chiefly at the nodes under the bud scales; also on *Loranthus* sp.". I have had no opportunity of examining this species, and cannot recognise it from the author's description.

**268. *Aspidiotus (Aonidiella) aurantii* Mask.**

Maskell, *Trans. N. Z. Inst.*, 1878, p. 109

Green, *Cocc. Ceyl.*, I, p. 58, Pl. XII, 1895

In Ceylon, on *Citrus* spp. and *Agave americana*. Elsewhere, recorded from every country in which *Citrus* fruits are cultivated.

**269. *Aspidiotus (Aonidiella) taprobanus* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 344, Pl. I, fig. 10, 1905

On leaves of *Phyllanthus myrtifolius*, usually on upper surface. Peradeniya. Recorded from Ceylon only.

**270. *Aspidiotus (Chrysomphalus) ficus* Ashm.**

Ashmead, *American Entomologist*, III, p. 267, 1880

Green, *Cocc. Ceyl.*, I, p. 43, Pl. V, 1896

I have met with this species, in Ceylon, on *Rhododendron arboreum* only. Elsewhere, it has a wide range, both of localities and host plants. I have records from India (on *Citrus*, *Phoenix* and *Bambusa*); from Australia (on *Cocos*); from Japan (on *Ilex*); Brazil (on palms, *Citrus* and *Bambusa*); Egypt, the Seychelles and U. S. America (on *Citrus* spp.) Mrs. Fernald, followed by other American authors, regards Ashmead's name for this species as a synonym of *Aonidium* L. This may be so, but the evidence of identity is not very conclusive.

**271. *Aspidiotus (Chrysomphalus) rossi* Mask.**

Maskell, *Trans. N. Z. Inst.*, XXIII, p. 3, 1890

Green, *Cocc. Ceyl.*, I, p. 45, Pl. VI, 1896

In Ceylon, on *Capparis* and *Garcinia*. Elsewhere, it ranges through Australia, Japan, and India to S. Africa. Brain regards the Ceylon form as a variety to which he has given the name *greeni* (*Coccidae* of S. Africa, III, p. 202); but the differences do not seem to be of sufficient importance to justify its separation.

**272. *Aspidiotus (Chrysomphalus) cistuloides* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 247, Pl. I, figs. 7-8, 1905

On foliage of *Cinnamomum* sp. Peradeniya. Recorded from Ceylon only. The peculiar form of the female puparium gives it the appearance of a small capsule resting on the leaf.

**273. *Aspidiotus (Chrysomphalus) dictyospermi* Morg.**

Morgan, *Ent. Mon. Mag.*, XXV, p. 352, 1889

I have collected this species, in Ceylon, on ivy, rose, *Cycas* and *Calophyllum*. It has a wide distribution throughout tropical Countries, upon an equally wide range of host plants. I have examples in my collection from India, Java, Mauritius, the Seychelles, Madeira, Algiers, Tripoli, Japan, Brazil and the West Indies.

**274. *Aspidiotus (Chrysomphalus) pedronis* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 341, Pl. H, fig. 4, 1905

On leaves of an undetermined tree: Pedrotalagala, at an altitude of about 8,000 feet. Recorded from Ceylon only.

**275. *Aspidiotus (Chrysomphalus) quadriclavatus* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 343, Pl. I, fig. 9, 1905

On upper surface of leaves of *Murraya exotica*. Peradeniya. Recorded from Ceylon only.

**276. *Aspidiotus (Targionia) phyllanthi* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 344, Pl. I, fig. 11, 1905

On the bark of *Phyllanthus myrtifolius*. Recorded from Ceylon only. The dull black scales are more or less concealed beneath the outer layer of bark.

**277. *Aspidiotus (Morganella) longispinus* Morg.**

Morgan, *Ent. Mon. Mag.*, XXV, p. 352, 1889

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 340, Pl. H, fig. 1, 1905

*Morganella maskelli*, Cockerell, *Bull. 6, T. S., Dep. Ag.*, p. 22, 1897

In Ceylon, beneath loose bark on stems of *Artocarpus integrifolia*. Peradeniya. Recorded also from the West Indies (on *Cupania*), Brazil Sandwich Islands, Mauritius (on *Hibiscus*), Hawaiian Islands, Algiers (on *Fraxinus*) and India (on *Bauhinia*).

**278. *Aspidiotus (Hemiberlesia) camelliae* Sign.**

Signoret, *Ann. Soc. Ent. Fr.*, (4), IX, p. 117, 1869

Green, *Cocc. Ceyl.*, I, p. 60, Pl. XIII, 1896

In Ceylon, on the stems and leaves of the tea plant, *Cinchona*, *Acacia* and numerous other plants. Occurring in tropical regions throughout the World.

**279. *Aspidiotus (Hemiberlesia) cuculus* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 341, Pl. H, figs. 2, 3, 1905

Occupies galls formed by *Amorphococcus mesuae*, on *Mesua ferrea*. Peradeniya.

**280. *Aspidiotus (Hemiberlesia) putearius* Green**

Green, *Cocc. Ceyl.*, I, p. 54, Pl. X, figs. 1-6, 1896

On the foliage of *Strobilanthes viscosus*, forming and occupying shallow pits on the undersurface of the leaves. Pundaluoya. Recorded from Ceylon only.

**281. *Aspidiotus (Cryptophyllaspis) occultus* Green**

Green, *Cocc. Ceyl.*, I, p. 56, Pl. XI, 1896

*Hemiberlesia occultus*, Leonardi, *Riv. Pat. Veg.*, VI, p. 129, 1898

*Cryptophyllaspis occultus*, Cockerell, *Check List, Suppl.* p. 396, 1899

Forming minute rounded galls on the upper surface of leaves of *Grewia orientalis*. Pundaluoya. Ceylon only.

**282. *Aspidiotus (Cryptophyllaspis) occultus-elongatus* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 345, Pl. I, figs. 12, 13, 1905

This variety differs from the typical form in the formation and position of the galls which are elongate and irregularly cylindrical, and are clustered on the under (instead of the upper) surface of leaves of *Grewia* sp. Heneratgoda. Recorded from Ceylon only.

**283. *Pseudaonidia trilobitiformis* (Green)**

*Aspidiotus trilobitiformis*, Green, *Ind. Mus. Notes*, IV, No. 1, p. 3, 1896

Green, *Cocc. Ceyl.*, I, p. 41, Pl. IV, 1896

In Ceylon, on *Dalbergia championii*, *Ixora coccinea*, *Nothopegia colebrookiana* and *Jasminum*. Pundaluoya. Recorded also from India (on *Mangifera* and *Psidium*): from the Seychelles (on *Citrus* and *Anacardium*): from Mauritius (on *Mangifera* and *Ficus*): from Australia

(on *Calophyllum*): from Zanzibar (on *Citrus* and *Ficus*): from Portuguese E. Africa (on *Anacardium*): from Japan and Formosa (on *Citrus* and *Ficus*), and from Brazil.

**284. *Pseudaonidia duplex* Ckll.**

Cockerell, *Psyche*, VII, suppl. i, p. 20, 1896

*Aspidiotus theae-rhododendri*, Green, *J. Bombay Nat. Hist. Soc.*, XIII, No. 1, Pl. A, figs. 2, 3, 1899

In Ceylon, on foliage of *Rhododendron arboreum*. Nuwara Eliya. Elsewhere, recorded from Japan, Hawaiian Islands, U. S. America (under glass) and India, on *Citrus*, tea, *Camellia* and various other plants.

**285. *Pseudaonidia malleolus* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 342, Pl. H, figs. 5, 6, 1905

On undersurface of leaves of *Mimusops hexandra*. Elephant Pass. Recorded from Ceylon only.

**286. *Pseudaonidia ambalangoda* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, p. 1007, fig. 1, 1922

Disposed along the midrib, on the upper surface of leaves of an undetermined shrub. Ambalangoda. Ceylon only.

**287. *Pseudaonidia tesserata* de Charm.**

De Charmoy, *Proc. Soc. Amid. Sci.*, p. 23, 1899

*Pseudaonidia oreodoxae*, Rutherford, *Bull. Ent. Research*, V, 3, p. 260, 1914

In Ceylon, on *Oreodoxa regia* and *Broussonetia*. Elsewhere in Mauritius (on *Vitis* and *Leucaena glauca*), and in S. Africa (on *Monotes glaber*).

**288. *Pseudaonidia clavigera* Ckll.**

Cockerell, *The Entomologist*, XXXIV, p. 226, 1901

*Pseudaonidia irrepta*, Rutherford, *Bull. Ent. Research*, V, 3, 1934  
(*Pseudaonidia gardeniae*, Rutherford, m.ss).

In Ceylon, on *Gardenia* and *Acalypha*. Elsewhere, in Natal, on *Camellia*. I have typical examples from Natal (ex Coll. C. Fuller, who was the original discoverer of the species). These have enabled me to identify Rutherford's supposed new species, with certainty. I think

that this and the preceding species must have been recent introductions into Ceylon. They were collected by Rutherford, in the Botanic Gardens at Peradeniya; but were never found by me, during 12 years intensive collecting in the same locality.

**289. *Odonaspis secreta* (Ckll.)**

*Aspidiotus secretus*, Cockerell, *Psyche*, VII, Suppl. i, p. 20, 1896  
Green, *Cocc. Ceyl.*, I, p. 64, Pl. XV, 1896

Concealed beneath the leaf sheaths of *Bambusa* and *Arundinaria* spp. Pundaluoya. Originally described from Japan. Recorded also from Antibes, France.

**290. *Odonaspis canaliculatus* Green.**

Green, *J. Bombay Nat. Hist. Soc.*, XIII, 1, p. 72, Pl. B figs. 6-8 and C fig. 9, 1899

Concealed beneath the sheathing bracts, at the base of branches of various species of *Bambusa*. Pundaluoya: Nuwara Eliya. Readily distinguishable by its dense, black scale and by the median canal opening on to the pygidial extremity. Recorded from Ceylon only.

**291. *Odonaspis penicillata* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 346, Pl. I, figs. 14-16, 1905

The scales are crowded on the stems of the Giant Bamboo—*Gigantochloa aspera*. Peradeniya. When found they were fully exposed, but must have been originally protected by the deciduous sheaths of the plant. This species is characterized by a close pencil of setae at the extremity of the pygidium. Recorded also from India, Japan and the Philippine Islands.

**292. *Odonaspis ruthae* Ehrh.**

Ehrhorn, *2nd. Bien. Rep. Corn. Hort. Cal.*, p. 26, 1901

At roots of a grass. Colombo. Originally described from the Hawaiian Islands. Recorded also from Egypt, Palestine, Australia, Mauritius and Rhodesia.

**293. *Odonaspis inusitata* (Green)**

*Aspidiotus inusitatus*, Green, *Cocc. Ceyl.*, I, p. 66, Pl. XVI, 1896

Secreted between the stem and leaf sheaths of *Arundinaria* sp. Yatiyantota and Udagama. A varietal form of the species has been recorded from Formosa.

294. *Odonaspis simplex* (Green)

*Chionaspis simplex*, Green, *Cocc. Ceyl.*, II, p. 160, Pl. LVII, 1899

Beneath leaf sheaths of various species of Bamboo. Pundaluoya and Peradeniya. Recorded also from India. Though the scale resembles that of a *Chionaspis*, the insect itself shows its affinity to the genus *Odonaspis*. MacGillivray has separated it and erected the genus *Poliaspoides* for the sole reception of this species.

295. *Greeniella cornigera* (Green)

*Aonidia corniger*, Green, *Ind. Mus. Notes*, IV, p. 5, 1896.

Green, *Cocc. Ceyl.*, I, p. 69, Pl. XVII, 1896

*Greeniella cornigera*, Cockerell, Check List, Suppl., p. 396, 1899

On upper surface of foliage of *Psychotria thwaitesii*, *Litsea zeylanica* and *Ostodes zeylanica*. Pundaluoya and Peradeniya. Recorded from Ceylon only. This species is easily recognizable by the series of stout, horn-like waxy processes radiating from the larval exuviae.

296. *Greeniella columnifera* (Green)

*Aonidia columnifera*, Green, *J. Bombay Nat. Hist. Soc.*, Dec. 1922, p. 1008, fig. 3

On the undersurface of leaves of *Turpinia pomifera*. Hakgala. Recorded from Ceylon only. Distinguished by a stout, cylindrical column of white wax on the larval exuviae.

297. *Aonidia loranthi* Green

Green, *Cocc. Ceyl.*, I, p. 74, Pl. XIX, figs. 1-5, 1896

Occupying shallow pits in the bark of *Loranthus* sp. Pundaluoya. Recorded from Ceylon only.

298. *Aonidia obscura* Green

Green, *Cocc. Ceyl.*, I, p. 74, Pl. XIX, figs. 6-9, 1896

Associated with the previous species, on *Loranthus*, but not pitting the surface of the bark. Ceylon only.

299. *Aonidia crenulata* Green

Green, *J. Bombay, Nat. Hist. Soc.*, XIII, 1, p. 74, Pl. D, figs. 14, 15, <sup>1890</sup>~~1899~~

On upper surface of leaves of *Memecylon umbellatum*. Peradeniya and Elephant Pass. Recorded from India also.

**300. *Aonidia mesuae* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XIII, 1, p. 74, Pl. D, figs. 16-18, 1899

On upper surface of *Mesua ferrea*. Peradeniya. Recorded from Ceylon only.

**301. *Aonidia perplexa* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XIII, 2, p. 252, Pl. E, figs. 19, 20, 1900

On undersurface of foliage of *Mesua ferrea*. Peradeniya. Recorded from Ceylon only.

**302. *Aonidia planchonioides* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XIII, 2, p. 252, Pl. E, figs. 20-23, 1900

On both surfaces of *Ficus* sp. Peradeniya. Ceylon only. The covering scale is translucent, revealing the form of the underlying insect.

**303. *Aonidia echinata* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 347, Pl. J, figs. 17-19, 1905

On *Hemicycilia sepiaria*. Anuradhapura and Batticaloa. Recorded from Ceylon only. The scales are thickly clustered on the underside of the leaves and are surrounded by a whitish bloom, such as is noticeable around many *Aleurodidae*. The specific name indicates the spinose character of the scale.

**304. *Aonidia pusilla* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 347, Pl. J, figs. 20, 21, 1905

On upper surface of leaves of *Carissa spinarum*. Elephant Pass, N. P. Recorded from Ceylon only.

**305. *Aonidia spatulata* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XIII, 1, p. 73, Pl. C, figs. 10-13, 1899

On upper surface of leaves of *Psychotria thwaitesii*. Pundaluoya. Recorded from Ceylon only.

**306. *Aonidia meschitinsa* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1009, fig. 4, 1922

On *Canthium montanum*. Hakgala. Recorded from Ceylon only. The insects occupy distinct depressions on both surfaces of the foliage, appearing as raised spots on the opposite surface.



307. *Aonidia mimusopis* Green

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, p. 1009, fig. 5, 1922

On *Mimusops hexandra*. Trincomali. Ceylon only. The scales are disposed along each side of the midrib, on the undersurface of the leaf.

308. *Aonidia ferrea* Ruthfd.

Rutherford, *Bull. Ent. Research*, V, 3, p. 265, 1914

"On twigs of *Mesua ferrea*". Peradeniya. Recorded from Ceylon only. I have not seen Rutherford's types of this species.

309. *Aonidia lauri* (Bouché)

*Aspidiotus lauri*, Bouché, *Schadl. Gart. Ins.*, p. 52, 1833

I have a rather doubtful record of this species, from Ceylon. The specimens were submitted by Dr. Horn (of Berlin) and are said to have been collected "on Cinnamon". But, as evidenced by both taste and smell, the plant is almost certainly *Laurus nobilis*, which does not occur naturally in the Indian Region. *A. lauri* has hitherto been known only from Southern Europe.

310. *Gymnaspis bullata* (Green)

*Aonidia bullata*, Green, *Cocc. Ceyl.*, I, p. 72, Pl. XVIII, 1896

On the foliage of an undetermined tree. Pundaluoya. Recorded from Ceylon only. Leonardi has pointed out that this species should be referred to *Gymnaspis* rather than to *Aonidia*.

311. *Gymnaspis spinomarginata* Green

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 348, Pl. J, figs. 24, 25, 1905

A small and obscure species occurring, in small groups, on the under-surface of leaves of *Mesua ferrea*. Peradeniya. Recorded from Ceylon only.

312. *Parlatoria proteus* (Curt.)

*Aspidiotus proteus*, Curtis, *Gard. Chron.*, p. 676, 1843

*Parlatoria proteus*, Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 349, Pl. J, fig. 26, 1905

On foliage of various orchids. Kandy: Watagoda. Recorded from nearly every part of the World, on many plants.

**313. *Parlatoria pergandii-mytilaspiformis* Green**

*Parlatoria mytilaspiformis*, Green, *Cocc. Ceyl.*, II, p. 164, Pl. XVIII, 1899

*Parlatoria pergandii* var. *mytilaspiformis*, Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 350, 1905

On foliage of *Psychotria thwaitesii* and on the tea plant. Pundaluoya. Distinguished from typical *pergandii* Comst. by the extremely elongate form of the scale.

**314. *Parlatoria pergandii-phyllanthi* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 350, Pl. J, fig. 27, 1905

On foliage of *Phyllanthus myrtifolius*. Peradeniya. Differs from type in the coloration of the scale, the secretionary area of which is pale translucent ochreous, the exuviae being bright castaneous with a conspicuous black median fascia.

**315. *Parlatoria cingala* Green**

Green, *Cocc. Ceyl.*, II, p. 166, Pl. LIX, 1899

On both surfaces of leaves of *Flacourtia* and *Scolopia*. Pundaluoya, Nuwara Eliya. Recorded from Ceylon only.

**316. *Parlatoria cingala-namunakuli* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1019, fig. 19, 1922

On leaves of an undetermined shrub. Namunakula Hill, Badulla. Recorded from Ceylon only. Differing in the structure of the outermost lobe (trulla) on each side of the pygidium, which—in typical *cingala*—is large and broadly rounded, but—in var. *namunakuli*—is small and lanceolate.

**317. *Parlatoria aonidiformis* Green**

Green, *Cocc. Ceyl.*, II, p. 168, Pl. LX, 1899

On upper surface of leaves of *Nothopegia colebrookiana*. Pundaluoya. Recorded from Ceylon only.

**318. *Parlatoria atalantiae* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 350, Pl. J, fig. 28, 1905

On undersurface of leaves of *Atalantia zeylanica*. Haragama. Recorded also from India.

319. *Parlatoria pseudaspidotus* Lindgr.

Lindinger, *Insecten Börse*, XXII, 33, p. 131, 1901

*Parlatoria mangiferae*, Marlatt, *Bull. U. S. Bur. Ent.*, 16, p. 28, 1908

On stems of *Euphorbia antiquorum*, in association with *Diaspis antiquorum*. Elephant Pass. This species has been recorded from India and Singapore, and from plant houses at Washington, U. S. A.

320. *Parlatoria cinnamomi* Ruthfd.

Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, p. 114, 1915

"On the upper surface of leaves of cinnamon, Peradeniya". Recorded from Ceylon only. I have not seen this species, but Rutherford describes it as being allied to *P. aonidiformis*.

321. *Parlatoria zeylanica* Ruthfd.

Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, p. 113, 1915

"Associated with *Chionaspis* (now referred to *Odonaspis*) *simplex* and *O. secreta* on a small species of Bamboo, Peradeniya". Ceylon only. I have not seen this species.

322. *Parlatoria rutherfordi* Green

*Parlatoria zeylanica*, Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, p. 114, 1915

*Parlatoria rutherfordi*, Green, *Cocc. Ceyl.*, V, Append. II, p. 465, 1922

"On undersurface of leaves of *Cinnamomum* sp., *Vitis* sp., *Sterculia thwaitesii* and *Polyalthia* sp., Peradeniya". Rutherford remarks upon "a distinct resemblance to *P. atalantiae*". The new name is necessitated by the fact that Rutherford had already described (on the previous page of his paper, loc. cit.), a *Parlatoria zeylanica*, n. sp., from *Bambusa*.

323. *Parlatoria mesuae* Ruthfd.

Rutherford, *Bull. Ent. Research*, V, 3, p. 266

"On the edges of leaves of *Mesua ferrea*; very inconspicuous". Peradeniya. Recorded from Ceylon only. Rutherford remarks of this species (which I have not seen) that "the insect bears a strong resemblance to a species of *Fiorinia*."

324. *Pseudoparlatoria parlatorioides* (Comst.)

*Aspidiotus parlatorioides*, Comstock, 2nd. Rep. Dep. Ent. Conn. Univ., p. 64, 1883  
Green, *Cocc. Ceyl.*, V, Append. II, p. 463, 1922.

On *Psidium* sp. Peradeniya. Recorded also from Florida (U. S. A.), Brazil, Mexico, Italy and India.

**325. *Pseudoparlatoria pusilla* Green**

Green, *J. Bombay Nat. Hist. Soc.*, XXVIII, 4, p. 1010, fig. 7, 1922

On *Theobroma cacao*. Peradeniya. Ceylon only. The scales are extremely inconspicuous and are distributed singly, at wide intervals, on the undersurface of the foliage.

**326. *Leucaspis cockerelli* (de Charm.)**

*Fiorinia cockerelli*, de Charmoy, *Proc. Soc. Amic. Sci.*, p. 33, 1899

*Leucaspis cockerelli*, Green, *J. Bombay Nat. Hist. Soc.*, XVI, p. 354, Pl. K, figs. 37-40, 1905

On *Dracaena cantleyi* and *Pritchardia grandis*. Peradeniya. Originally described from Mauritius, on *Citrus*. When attached to *Pritchardia* the scales—though numerous—are very inconspicuous, being ranged along the prominent ridges of the leaf, where they simulate adpressed scaly hairs.

**327. *Leucaspis limoniae* Ruthfd.**

Rutherford, *J. Bombay Nat. Hist. Soc.*, XXIV, 1, p. 117, 1915

“On leaves and petioles of *Limonia alata*: Peradeniya”. Ceylon only. I have not seen this species. Rutherford remarks that the “insect resembles *Leucaspis cockerelli*, but the lobes are of a different shape and are not notched, while the pectina are longer, extending well beyond the lobes”.

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*Euprepocnemis kalkudensis*, sp. nov. (Insecta, Acrididae)  
from Ceylon; with Remarks on *Euprepocnemis alacris*  
(Serville) in the Island

BY

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(With One Plate)

The Colombo Museum possesses sixty specimens of Ceylonese *Euprepocnemis*. These have all been treated as *E. alacris* (Serville) (1893), but, on critical examination of the whole series, it became apparent that it contained, besides *E. alacris*, a number of specimens belonging to a distinct species. While on furlough in England in 1935 I took the opportunity of comparing one of these specimens with the British Museum collection of *Euprepocnemis*, and reached the conclusion that it was an undescribed form. My grateful thanks are due to Dr. B. P. Uvarov for assistance in determining this insect.

***Euprepocnemis kalkudensis*, sp. nov.**

(Plate XIV, figs. 1-4)

Closely related to *E. alacris* (Serv.), but differing in the following features. Smaller; face more oblique; eyes less prominent; vertex medially carinulate, the carinula not extending forwards beyond the base of the fastigium (in a specimen of *E. plorans* from Valencia, Spain, for which I am indebted to Dr. C. Willemse, the fastigium is divided throughout by this carinula); tegmina short, in both sexes extending little, if at all, beyond the apex of abdomen, and not reaching the hind knees; hind femora sanguineous on the lower, inner face—in some specimens, on part of the lower outer face as well; hind tibiae dull greenish blue with two pale annulae in the proximal third—no trace of sanguineous. The tibial spines, numbering normally eleven outer, ten inner, are white basally, black apically.

The male tenth tergite possesses a pair of small, tooth-like processes on its distal margin; their form varies somewhat and they are not quite so prominent in some specimens as in the one figured (Plate XIV, fig. 3). The supra-anal plate is relatively shorter and broader than in *E. alacris*; the cerci are shorter and less inclined to be falcate and compressed at the tip.

The general coloration is as in *E. alacris*.

*Measurements in mm.*

	♂		♀	
Length	22.5	to 24.0	30.5	to 36.5
Width of head at eyes	3.75	to 4.0	4.7	to 5.2
Length of pronotum	4.2	to 4.4	5.5	to 6.1
Length of tegmina	15.5	to 18.0	22.2	to 23.7
Length of hind femur	12.8	to 14.0	18.2	to 20.8

*Material examined.* Type ♂, five other males and three females taken at Kalkudah, Eastern Province, in scrub jungle on the sea-coast, on 24-iv-1931; one female taken at Talaimannar, in scrub jungle, 27-29-v-1934. The Talaimannar female is somewhat larger and more brightly coloured than the Kalkudah specimens but otherwise shows no difference.

The type, another male, and a female will be deposited in the British Museum (Natural History) on publication of this paper.

### ***Euprepocnemis alacris* (Serville)**

This species is widely distributed in the Island, as may be seen from the following list of localities from which specimens in the Colombo Museum were collected.

Colombo (ca. 10 feet); Battaramulla, W. P. (ca. 10 feet); Polpitiya N. W. P.; Peradeniya, C. P. (ca. 1,200 feet); Kandy, C. P. (ca. 1,800 feet); Mousakande, Gammaduwa (ca. 3,000 feet); Polonnaruwa, N. C. P. (ca. 500 feet); Kantalai, E. P. (ca. 200 feet); Vavuniya-Medawachchiya road (ca. 250 feet); Kumuna Wewa, E. P. (ca. 15 feet); Katagamuwa, S. P. (ca. 50 feet); Wellawaya, Uva P. (ca. 604 feet); Badulla, Uva P. (ca. 2,200 feet); Demodera, Uva P. (ca. 2,800 feet); Uda Pussellawa, Uva P. (ca. 4,000 feet); Ragala, C. P. (ca. 5,050 feet); Hakgala, C. P. (ca. 5,500 feet); Nuwara Eliya, C. P. (6,189 feet); North Punduloya, C. P. (ca. 5,000 feet); Ratnapura, Sab. P. (ca. 100 feet).

The specimens from Hakgala (15), Nuwara Eliya (1), and Ragala (2), show a marked difference from the normal in having relatively shorter and broader tegmina, which are almost unspotted but have all

the main veins rather strongly and uniformly pigmented (Plate XIV, fig. 5). I have been tempted to propose a subspecific name for these specimens, which probably represent a montane race (all three localities being within a radius of four miles, and situated on the same mountain massif, above 5,000 feet); however, on second thoughts, I have decided against this course as some specimens show a tendency to vary towards the typical form and it is desirable to await the results of further collecting in the montane region before giving the form definite subspecific rank. It is of interest, however, to note that a pair recently collected at North Punduloya (ca. 5,000 feet, about seven miles from Nuwara Eliya, on the same massif but on the opposite watershed from Nuwara Eliya, Ragala, and Hakgala) are nearer to the typical form.

As a general rule, Ceylonese specimens of *E. alacris* appear to be smaller and darker than those from the mainland of India; but I have insufficient Indian material to be able to dogmatise on this point.

*Euprepocnemis alacris* favours fairly open country, flat or hilly, on which long, coarse grasses, such as "illuk" (*Imperata arundinacea* Cyrill.) and "māna" (*Cymbopogon confertiflorus* Stapf.), flourish. It is usually abundant where found.

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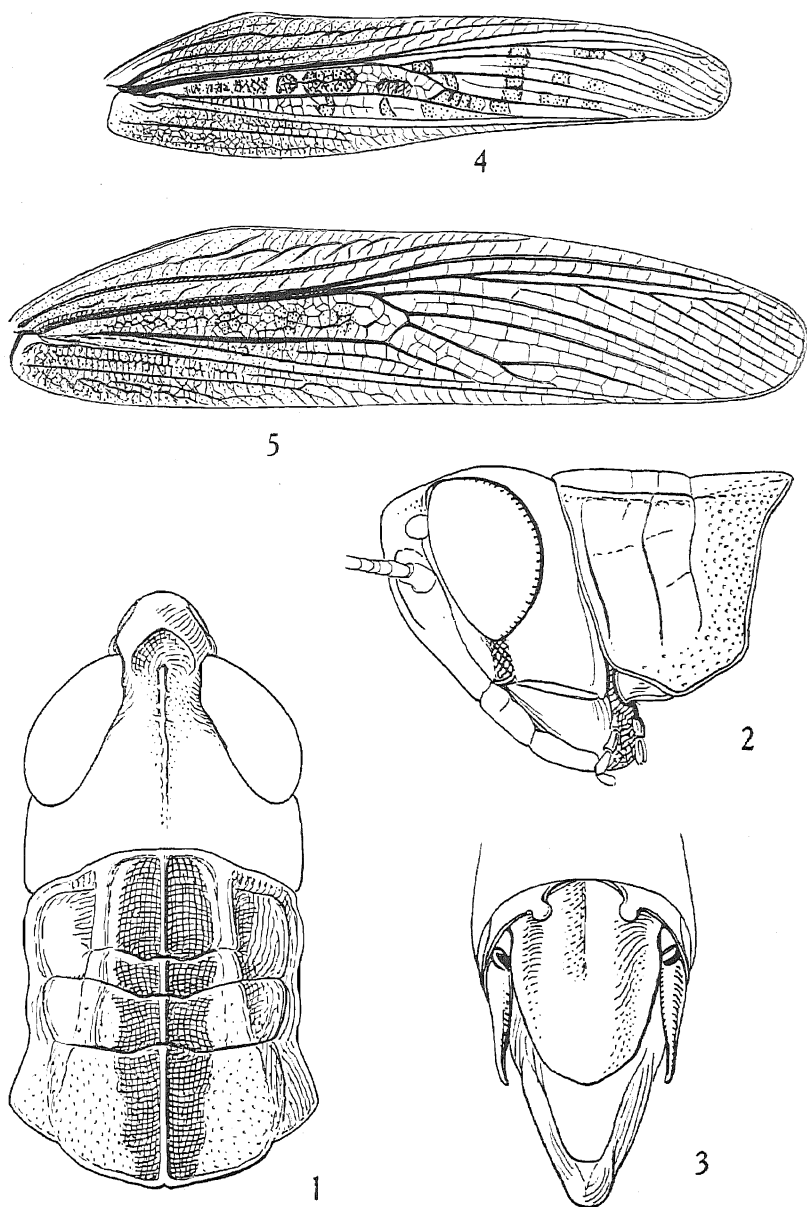
#### EXPLANATION OF PLATE XIV

##### PLATE XIV.

- Fig. 1. *Euprepocnemis kalkudensis*, sp. nov., ♀, head and pronotum, dorsal. × 8  
 Fig. 2. *Euprepocnemis kalkudensis*, sp. nov., ♂, head and pronotum, lateral. × 8  
 Fig. 3. *Euprepocnemis kalkudensis*, sp. nov., ♂, genitalia, × 16  
 Fig. 4. *Euprepocnemis kalkudensis*, sp. nov., ♀, tegmen, × 4  
 Fig. 5. *Euprepocnemis alacris* (Serv.), tegmen of a Hakgala specimen. ♀, × 4







G. M. Henry del.

Fig. 1-4. *Euprepocnemis kalkudensis*, sp. nov.

Fig. 5. *Euprepocnemis alacris* (Serv.), var.



## The Sword fish *Xiphias* of the Indian Ocean

BY

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(With Two Plates)

The existence of the sword fish *Xiphias* in the tropical portion of the Indian Ocean had long been in doubt and it was only recently that its presence was definitely established by a rostrum described and figured previously (Deraniyagala 1936). As far as is known, there is no other description or illustration of this fish from the seas of Ceylon and India. It is apparently very scarce off the east coast of Africa for according to Copley (1935) there is no definite record of *Xiphias* from East Africa. He adds that the "late Dr. A. H. Spurrier of the Zanzibar Museum, in all his years of experience, had never seen a specimen", but admits that there is an old skull and sword in the South African Museum, "which may have come from anywhere". *Xiphias*, however, is not uncommon in the Pacific and is a prized game fish off New Zealand where it is known to anglers as the "broad-bill", and has been identified as a new species, *Xiphias estara* by Phillips (1932) who examined a sketch by one Mr. Clarke and also a mounted specimen in the Dominion Museum, New Zealand. As the specific characters he enumerates are trivial they might well result from distortion in a mounted specimen while Clarke's drawing which he figures (1926), is not very convincing.

The presence of *Xiphias* in Ceylon waters is based on the following facts. (1) Haly (1887) assigned the rostrum and the sketch of a specimen taken at Hikkaduva in January, 1887, to this fish but left no description to prove the correctness of his identification.

(2) The material from Ceylon examined by the writer comprises the rostrum<sup>1</sup> of a specimen taken off Gandra (Southern Province) in 1935, an entire specimen taken off the same village on September 23, 1936 (Plates XV-XVI) and two rostra from fishes captured about 40 kilometers off Trincomalee (Eastern Province) on April 22, 1937.

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<sup>1</sup> Deposited in the British Museum (Deraniyagala 1936).

The second Gandera specimen was taken by trolling from an outrigger canoe. The bait employed was the squid *Loligo indica* and the distance of the canoe from shore can be gauged by the fisherman's statement that the summit of the Dondra lighthouse was flush with the horizon, this lighthouse being 48.8 metres (160 feet) high, while the 1829 metre (1,000 fathom) isobath is only 9.6 kilometres (six miles) from the shore.

The fish was a dark grey dorsally, with black fins, silver grey sides and white belly. Its dimensions in cm. were as follows:—Length of rostrum 89; diameter of eye 6.5; length of postorbital part of head 24; length of lower jaw 24; length of pectoral fin 36; height of first dorsal 36; height of second dorsal 5; height of first anal 21; height of second anal 5; distance between dorsals 69; distance between tips of caudal lobes 64; width across caudal peduncle dorsally 21; eye to end of preopercle 9; preopercle to gill slit 15; depth of body 35; standard length 223. The gape extended behind the eye and the end of the maxillary was not free as in *Makaira*, the depressed rostrum was bent slightly to the right near its apex. There was a nick at the tip of the caudal peduncle both dorsally and ventrally. (Plate XVI.)

The fin formula was as follows:—I D 2.15, last two rays small; P 2.14; A 3.9. Branchiostegals 7, psedobranchiae developed. Air bladder present, not complex as in *Makaira*. According to the fishermen of Gandera four or five specimens had been captured previously in September, 1936, and this fish, although rarer than either *Istiophorus* or *Makaira*, could not be regarded as uncommon. Further investigation has also revealed that although the fishermen of the south and east coasts of Ceylon are quite familiar with *Xiphias*, which they term 'Kadu koppera', 'kaduva' meaning sword and 'Koppera', *Makaira* in Sinhalese, the fish is unknown from the other coastal areas.

The sword fish of the tropical Indian Ocean is *Xiphias gladius* Linné; it is not uncommon in the deep water to the south and east of Ceylon, where it has been taken from September to January and in April respectively. It is possible that the fish migrates thither from temperate waters during this period. It is equally probable that the fish is always present off Ceylon, but is only taken when monsoon conditions enable the narrow Sinhalese fishing canoes to sail beyond the continental shelf into deeper water. Should the fish prove to be a permanent resident in the deep water off Ceylon, more seaworthy craft than the outrigger canoe might establish an important fishery of this large, well flavoured fish, which is usually taken with the harpoon rather than the hook, as off Massachusetts where the annual catch for 1919 was 1,136,542 lb. valued at \$270,164.

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## EXPLANATION OF PLATES XV-XVI

## PLATE XV.

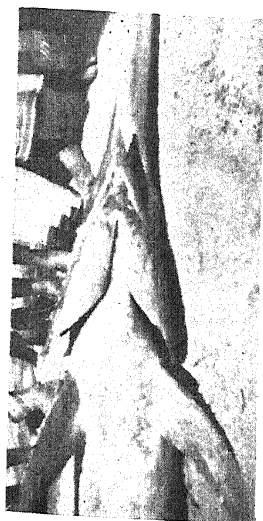
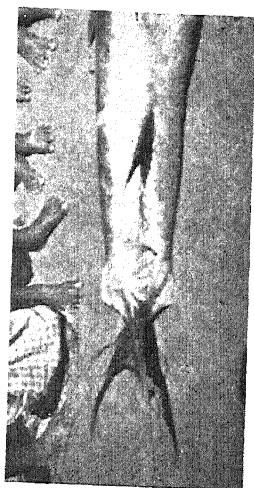
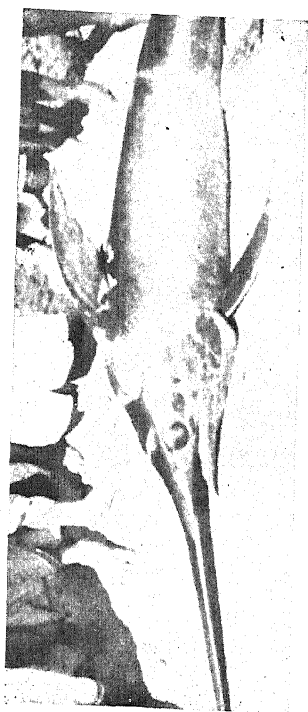
Photographs of *Xiphias gladius* Linné, captured off Gandera on September 23, 1936  
Figs. 1-4 lateral views; fig. 2 ventral view of tail. Fig. 3 gular view

## PLATE XVI.

A drawing of the *Xiphias gladius* Linné, captured off Gandera on September 23, 1936  $\times \frac{1}{1.5}$  natural size

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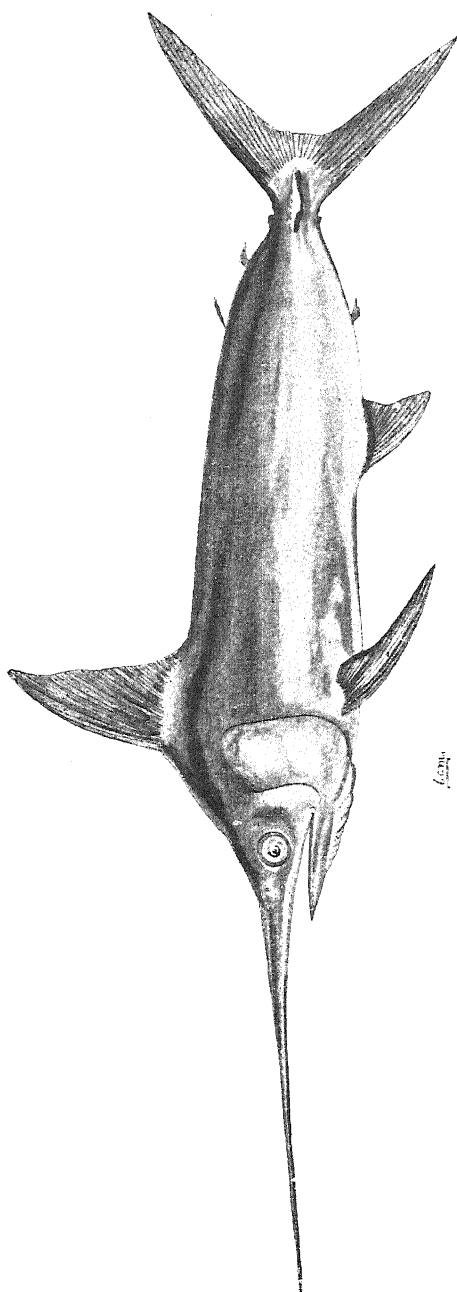




*Xiphias gladius* Linné, from Ceylon







Linn.

*Xiphias gladius* Linné, from Ceylon  $\times \frac{1}{15}$

P. Deraniyagala del.



## *Malpulutta kretseri*—A New Genus and Species of Fish from Ceylon

BY

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(With One Text Figure)

The Anabantoidea hitherto known from Ceylon are *Anabas* Cuvier, *Belontia* Myers<sup>1</sup> and *Macropodus* Lacépède, while *Osphronemus* Lacépède, has been introduced.

The three indigenous forms are characterized by possessing more spines than rays in their unpaired fins. The new fish resembles these in this feature, but differs in possessing fewer dorsal spines and having the origin of the anal fin in advance of the dorsal. Many Anabantoidea possess filamentous fins and a tendency to surpress the lateral line; both features are displayed by the new form, which is closely allied to *Macropodus*, but differs from it in possessing a lesser number of dorsal spines, a filamentous dorsal fin and in the fact that the ventral spine does not reach the origin of the anal fin. It differs from *Belontia* in its fewer dorsal spines and in possessing the origin of the anal slightly in advance of that of the dorsal, and from *Sphaerichthys* in possessing fewer anal rays than spines and in possessing filamentous dorsal and caudal fins.

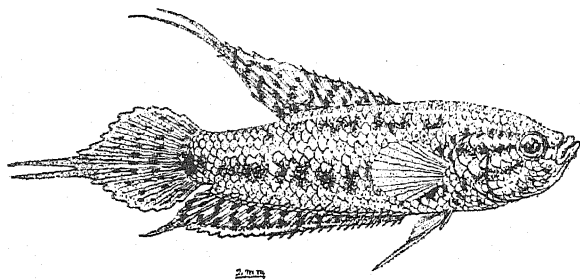
### *Malpulutta*<sup>2</sup> gen. nov.

Oblong, elongate, compressed. Mouth feebly protractile, its cleft oblique, lower jaw prominent. Jaw teeth conical, fixed. Opercular bones entire, only the horizontal limb of preopercle feebly serrate. Scales ctenoid, lateral line vestigial. Dorsal and anal fins with rays divided, scaly bases and more spines than rays. Dorsal spines eight to ten. Ventral with one spine and five rays, the first forming a single articulated filament. Pectorals rounded, all other fins filamentous.

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<sup>1</sup> *Belontia* Myers replaces *Polyacanthus* (Kuhl), Cuvier.  
<sup>2</sup> *Malpulutta* is derived from Sinhalese words 'mal' flower; and 'pulutta', the fish *Belontia signata* (Günther).

A genus of small, fresh water fishes intermediate between *Macropodus* Lacépède, and *Sphaerichthys* Canestrini.



P. Deraniyagala del.

Fig. 1. *Malpulutta kretseri* gen. et sp. nov.  $\times 2$

### ***Malpulutta kretseri* sp. nov.**

The present species is named in honour of Mr. L. de Kretser who first presented the writer with a living specimen and subsequently showed him two others<sup>1</sup>, which were examined alive in a small, flat sided, glass specimen jar. P. 12; V 1.5; D VIII—X. 6, A. XVI—XVII; 9-11, C. 15; LL 29-30; L tr. 9-10 or 4/6. Br. 7.

Head 3, eye 3.7, snout 0.7 in orbit, depth 3.5. Lateral line vestigial, restricted to six scales.

Snout shorter than orbit; gape small, remote from orbit; mouth protractile, posterior angle and lower limb of preopercle serrate. Head bluntly acuminate; jaw teeth fixed, pluriserial, conical. Pectoral fin as long as postorbital part of head plus half orbit and contained 4.8 in entire length of fish. Ventral inserted under pectoral fin. Length of outer ventral fin ray equals head minus snout. Caudal fin of adult about half as long as fish and with its two median rays filamentous. Dorsal originates a little behind the origin of anal, its two median rays elongate. Anal with eighth ray forming a single filament. Both fins with scaly bases.

Specimens with standard length under 20 mm. do not display strongly filamentous fins. In specimens 25 mm. long the fins are apt to possess only one filament, while specimens over 25 mm. possess a filamentous ray to both dorsal and caudal, and the mouth is apt to be undershot. The anal and ventral filaments do not appear to increase

<sup>1</sup> Only the dorsal spines could be counted accurately in these two specimens.

in relative length after the animal attains to 22 mm. in length. The male possesses a more convex forehead than the female, which possesses darker blotches prior to oviposition.

Scales ctenoid, preentrals 8, scales from eye to posterior edge of preopercle 3 or 4; scales across opercle 2 above, 3 below. Isthmus scaly.

*Colours.* Cinnamon-brown, lighter ventrally. A light neural stripe from snout to dorsal. Opercles reddish. Three black lateral bands from eye to hind edge of opercle; of these the middle one is the most distinct and is produced anteriorly to the snout tip. The two lower bands are continued a short distance down the body, then unite and are represented by a series of blotches, which again tend to unite posteriorly. The upper lateral cephalic band is continued as a row of blotches until under the posterior of the dorsal fin. A few spots on throat and chest and a well marked shoulder spot and another at end of caudal peduncle. Single fins with a greenish blue margin and with oblique rows of black spots, nine upon the dorsal and about sixteen upon anal. About three irregular rows of spots across caudal fin.

*Distribution.* A fresh water fish inhabiting ponds adjacent to small streams. Buries itself in the mud if disturbed. In captivity feeds on boiled rice, meat, crumbled dried prawns, or mosquito larvae.

Dandegamuva, Nikaveratiya, Hettipola (North-western Province); Gilimalé (Sabaragamuva Province); Ceylon. The type, 25 mm. standard length, with D. IX.6 and A XVII.11, is deposited in the British Museum.

In conclusion I must express my gratitude to Mr. J. R. Norman who compared the type with the collection of *Macropodus* in the British Museum, to Dr. S. L. Hora, and Mr. D. D. Mukerji of the Indian Museum who sent me useful information on *Parosphromenus* and *Sphaerichthys* which was of help in determining the generic status of *Malpulutta kretsei* and to Mr. E. Matthews who presented me with an adolescent living specimen from Gilimalé.

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## Some Miocene fishes from Ceylon

BY

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(With Nine Text Figures)

The present paper describes the first fish fossils discovered in Ceylon. The collection comprises six genera of Selachii, with as many species; and three genera with as many species of Pisces, all known only from teeth. While many of these genera possess living species, only one or possibly two, of the nine species now recorded are recent. The fossils were obtained from rocks of Miocene age which are exposed between tide marks along the east shore of Dutch Bay at Aruakallu also known as Muringé Malé in the North-Western Province of Ceylon at 8° 17' N by 79° 49' E.

Dutch Bay is the name given to the mouth of the Puttalam lagoon and ranges in depth from a half to three and a quarter fathoms. On both sides of the bay are natural salt lakes and some of the eastern ones are nearly eighteen kilometres (eleven miles) inland. Analysis for the solid content in the water of some shows that it is nearly equal to that of sea water and well in excess of samples from mineral springs in the Eastern Province of Ceylon (see appendix). In this connexion it is interesting to note that adjoining Aruakallu and to its north are several remarkable arid tracts which have been regarded as incipient deserts (Wayland 1919).

The instability of this region is also illustrated by the movements of the six or seven islands in Dutch Bay. The rapidity with which these alter can be ascertained by reference to old and modern charts for this district, which has received especial attention owing to the valuable pearl-oyster banks which lie off the coast. Donnan's chart (1891) depicts a large island he terms Mutwal Island to the west of Dutch Bay, and, to the north, another comprising two localities, viz., Karativu and Kawdari, while Ippantivu was barely separated from the latter by a narrow channel.



Kerkham's chart (1910), on the other hand, shows Mutwal Island divided into two, of which the northern one is termed Dutch Bay Land; while Ippantivu is now separated from Kawdari by nearly twice its own length and a tract as long as Kawdari. Stubb's chart (1935) shows Mutwal Island and Dutch Bay land reunited and connected to the mainland, while the Karativu tract has separated off from Kawdari which he has named Karativu South. To the south of the latter is a sunken forest extending to the two fathom line. This is the elongate projection of land depicted by Donnan (1891).

With reference to Aruakallu itself, the land to the east of Dutch Bay rises as a ridge of small hills reaching a maximum height of 79 m. (260 feet) at Aruakallu (Coates 1935, p. 105) barely a kilometre from the shore. The upper stratum consists of dark red sand, bleached white at the surface, and covers sedimentary deposits.

It was from the beach, west of Aruakallu hill, that the fossils here described were obtained from rocks which lay between tide levels. Associated with these and throughout the upper deposits to a height of about three metres above the sea were found the following fossil molluscs:—Two species of *Ostrea*, the smaller probably *vireleti* Deshayes; an abundance of *Placuna* cf. *miocenica*; *Chlamys senatoria* (Gmelin); *Chlamys* cf. *plica* (Linné); *Antigona* cf. *puerpera* (Linné); *Tellina* sp.; *Brechites* cf. *vaginifer* (Lam.); *Strombus* sp.; *Cypraea* sp.

In addition to these, there lay at the same level as the fish fossils, parts of a vertebrate, which was probably a large thecophoran turtle (Deraniyagala 1937). The writer considered the fossils of Miocene age but as no vertebrates had been obtained, either by E. J. Wayland formerly Mineralogist to the Ceylon Government when he examined this district from 1914 to 1916 (Wayland 1921, p. 407), or by his successor J. S. Coates (Coates 1935, p. 107) he submitted the collection to Dr. E. I. White of the British Museum for his opinion.

The latter agreed with the writer's estimate of the age of the fish fossils. He considered them a typical Miocene assemblage well worth description and kindly furnished the writer with much valuable information.

The level from which the fish fossils were obtained is probably lower than the ones investigated by either Wayland or Coates, and, as far as known, is only exposed in the neighbourhood of Aruakallu. The name *Malu*<sup>1</sup> is here suggested for those Miocene deposits of Ceylon which are characterized by fossils of marine fishes. The types here described will be deposited in the British Museum.

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<sup>1</sup> *Malu* is the Sinhalese equivalent for "fish".

The first fish fossils recorded from Ceylon are as follows :—

Class Selachii

Subclass Euselachi

Order Pleurotremata

Fam. Isuridae

gen. *Isurus* Rafinesqué

(1) *Isurus* sp.

Fam. Eulamidae

gen. *Glyphis* Agassiz

(2) *Glyphis minor* (Agassiz)

gen. *Galeocерdo* Müller et Henlé

(3) *Galeocерdo arcticus* (Faber)

gen. *Hemipristis* Agassiz

(4) *Hemipristis serra* Agassiz

Order Hypotremata

Fam. Myliobatidae

gen. *Myliobatis* Cuvier

(5) *Myliobatis sinhaleyus* sp. nov.

gen. *Actobatus* Blainville

(6) *Actobatus sinhaleyus* sp. nov.

Class Pisces

Subclass Neopterygii

Order Percomorphi

Fam. Pharyngopilidae

gen. *Labrodon* Gervais

(7) *Labrodon sinhaleyus* sp. nov.

Fam. Callyodontidae

gen. *Callyodon* Gronow

(8) *Callyodon* sp.

Order Plectognathi

Fam. Diodontidae

gen. *Diodon* Linné

(9) *Diodon sinhaleyus* sp. nov.

## Order PLEUROTREMATA

## Family Isuridae

Teeth solid, pointed, variable, some flexuous. Eye without a nictitating membrane, gill openings wide. Caudal fin lunate; its peduncle depressed and with pits. Large oceanic sharks.

genus *Isurus* Rafinesque

*Isurus* Rafinesquè 1810 Caratteri Nuov. An. Sicil., p. 11

*Isuropsis* Gill 1861 Ann. Lyc. Nat. Hist. N. Y. VII

Teeth without lateral cusps, elongate, flexuous and with sharp entire edges; dentition wanting at symphysis, longest in lower jaw and in two functional series of teeth. Caudal peduncle with a prominent lateral keel. A pit at end of caudal peduncle. Second dorsal and anal fins much reduced.



P. Deraniyagala del.

Fig. 1. Teeth of *Isurus* sp.  $\times 1.5$

*Isurus* sp.

Teeth of this species were fairly common and somewhat variable in width. It is probably allied to *Isurus crassidens* (Dixon). The tooth figured (fig. 1) is 16 mm. high and 3 mm. wide. A shallow basal groove extends for about one-third of the length of the cusp which is mounted on a strong and feebly bilobate base. The cusp shows two curves; apically it is concave labially, convex lingually; basally these curves are in reverse order.

*Distribution.* Miocene of Ceylon. The living species *Isurus cepedei* (Lesson), is not uncommon off the south coast of Ceylon during the month of September.

Family Eulamidae

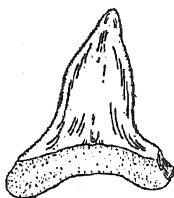
Teeth hollow, usually acute and pluriserial. Eye with nictitating membrane. Dorsals two, the first of these opposite to space between pectorals and ventrals. Tail compressed, without carinae.

genus **Glyphis** Agassiz

*Glyphis* Agassiz 1843. Poiss. Fossiles 111, p. 243

*Prionodon* Müller et Henlé 1838. Syst. Beschreib. der Plagistomen, p. 35

Teeth subtriangular with entirely serrate margins. Upper teeth broader than lower ones. Spiracles wanting. Caudal fin with prominent lower lobe, and a pit at end of caudal peduncle. Two extinct species; a living species inhabits tropical and temperate seas.



P. Deraniyagala del.

Fig. 2. Tooth of *Glyphis minor* (Agassiz)  $\times 1.4$

***Glyphis minor* (Agassiz)**

*Carcharias minor* Agassiz 1837 in Egerton's list of Fossil Fishes

*Corax egertoni* Agassiz 1843 Poiss. Fossiles Vol. III, p. 228

*Carcharias (Prionodon) egertoni* Woodward 1889 Cat. Fossil Fishes Brit. Mus. pt. 1, p. 439

Tooth with fine, subequal marginal serrations. The cusp narrows somewhat abruptly to the apex and expands to a wide base. At base of cusp there is an ill defined median carina. Both margins of the cusp are concave at the base, convex towards the middle of the height of the cusp and converge at the apex (fig. 2).

*Dimensions.* Height of tooth 15 mm., length of anterior margin 17 mm., of posterior margin 15 mm., width of base 15 mm.

*Distribution.* Miocene of Ceylon, Eocene of S. Carolina, Miocene of Maryland, U. S. A.; Miocene of Naples, Lower Tertiary of Birket-el-Qurun, Egypt.

genus **Galeocerdo** Müller et Henlé*Galeocerdo* Müller et Henlé 1837 Syst. Akad. wiss. Berlin, p. 115

Teeth subequal, oblique, deeply notched posteriorly and with coarsely serrate margins. Labial groove inconspicuous. Nictitating membrane present. Spiracles minute, a pit both above and below end of caudal peduncle, its fin with a double notch.



P. Deraniyagala del.

Fig. 3. Tooth of *Galeocerdo arcticus* (Faber)  $\times \frac{1}{4}$ **Galeocerdo arcticus** (Faber)*Squalus arcticus* Faber 1829. Fische Islands, p. 17

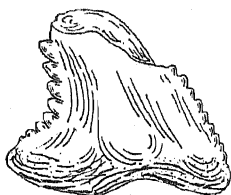
Teeth stout, with completely serrate margins. A tooth comprises three cusps, the first much larger than and bent over the other two. The serrations are strong and tricuspid half way up the first cusp, after this they become fine and continue so along the posterior margin of the cusp and on to the second after which they again become large. The anterior margin of the first cusp is convex over the area with large serrature; above this it is concave and its posterior margin in convex. Along the labial or flatter surface of the tooth is a diffuse basal groove (fig. 3).

*Dimensions.* Height of tooth 11 mm., thickness of tooth 5 mm., length of base 23 mm., height of first cusp above the second 8 mm. A large species said to reach a length of 300 cm. or more (Fowler 1936, p. 56).

*Distribution.* Miocene of Ceylon, France, Switzerland and Germany. Found alive in tropical seas to about 70° from the equator (Fowler 1936, p. 56).

genus **Hemipristis** Agassiz*Hemipristis* Agassiz 1843. Poiss. Fossiles Vol. III

Main teeth triangular and curved backwards, margin of tooth strongly serrate, except towards apex. Upper teeth relatively larger than lower which have no serrations.



P. Deraniyagala del.

Fig. 4. Tooth of *Hemipristis serra* (Agassiz) minus the tip  $\times 1.8$

### ***Hemipristis serra* Agassiz**

*Hemipristis serra* Agassiz. 1843. Poiss. Foss. Vol. III, p. 237, Pl. XXVII, figs. 18-30

This species is known from a single tooth in which the apex of the cusp is broken. The base of the tooth is wide and in cross section forms two wide bends. Along the median axis of the cusp is a diffuse carina. There are nine serrations along its convex margin, eight along the other (fig. 4).

*Dimensions.* Height of tooth 13 mm., width of base 16 mm., thickness of cusp 5 mm.

*Distribution.* A typical Miocene form, sometimes occurring in Eocene strata. The Miocene of Ceylon; Switzerland; Wurtemberg; Bordeaux; Lisbon; Malta; Darien, Central America; Maryland, South Carolina, Alabama, U. S. A.

## Order HYPOTREMATA

### Family Myliobatidae

Teeth angular, forming a titurating mosaic; median row wider than laterals if any such are present. Mouth opening straight. Pectoral fins enlarged, interrupted at sides of head but reappearing as small cephalic fins at extremity of snout to form a rayed pad. Tail fine and elongate. Large rays feeding largely on molluscs. Seven extinct and four living genera.

genus ***Myliobatis* Cuvier 1817**

*Myliobatis* (Dumeril) Cuvier 1817 Règne Animal II, p. 137

Teeth large, flat, forming a mosaic and arranged in seven rows. Dentition of upper jaw arched, of lower jaw flat, dental crown smooth or feebly striated. Teeth subequal, the median row very broad, whereas

the teeth of the three lateral series on each side rarely broader than long. Many extinct and seven living species. Large rays of tropical seas.



P. Deraniyagala del.

Fig. 5. Part of tooth band of *Myliobatis sinhaleyus* sp. nov. (type)  $\times \frac{1}{4}$

### *Myliobatis sinhaleyus* sp. nov.

The specimen (fig. 5) comprises five straight tooth plates from the median series each about eight times as wide as long. The outer margin of the first is dentate and possesses about fourteen low protuberances. The species is probably allied to *M. angustidens* Sismonda.

*Dimensions* (of type) width 28 mm., length 13 mm.

*Distribution.* Miocene of Ceylon. The living species *Myliobatis maculatus* Grey et Hardwicke, is abundant in Dutch Bay.

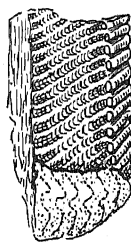
genus *Aëtobatus* Blainville 1816

*Aëtobatus* Blainville 1816 Bull. Soc. Philom. Paris, p. 112

Teeth flat, very broad and uniserial. Upper dentition strongly arched; the lower flat with teeth either straight or more or less angularly bent in the middle; the lower dental pavement is produced anteriorly.



a



b

P. Deraniyagala del.

Fig. 6. Teeth bands of *Aëtobatus sinhaleyus* sp. nov.

(a) type with matrix attached  $\times \frac{1}{4}$  (b) a co-type  $\times 2$

***Aëtobatus sinhaleyus* sp. nov.**

A portion of the lower tooth pile comprising twenty lamellae (fig. 6a). Each of these is furnished with a pair of lateral tubercles which are grouped into two lateral ridges along the entire pile (fig. 6b). This species is probably allied to *A. irregularis* Agassiz.

*Dimensions* (of type). Length of tooth pile 30 mm., width of pile 12 mm., depth 8 mm.

*Distribution*. Miocene of Ceylon. The living form *Aëtobatis narinari* (Euphrasen) abounds in Dutch Bay and occurs in all tropical seas.

Order PHARYNGOGNATHI

Family Pharyngopilidae (Phyllodontidae)

A small, extinct family of Labroid fishes with the upper pharyngeals united and the median teeth enlarged. Extinct.

genus **Labrodon** Gervais 1857

*Labrodon* Gervais 1857. Mém. Acad. Sci. Montpellier III

Pharyngeal teeth tritoral, close set and each with successional teeth beneath it. Pharyngeal bone triangular, an extinct genus of the Eocene and Miocene.



P. Deraniyagala del.

Fig. 7. Pharyngeal teeth of *Labrodon sinhaleyus* sp. nov. (type)  $\times 2.5$

***Labrodon sinhaleyus* sp. nov.**

This species is allied to *Labrodon multidentis* (Münster) from the Miocene of Austria, France, and Italy and is known from parts of the pharyngeal dentition of two individuals. The upper layer of teeth which are in wear are about thrice as high as those of the next successional layer. There are about five successional layers.

The pharyngeal teeth, as far as known, are arranged in four rows crossed by fourteen rows. The crowns of the teeth are smooth and convex and tend to overlap one another (fig. 7).



*Dimensions* (of type) length of crown surface of entire structure 10 mm., depth of structure 9 mm., length of tooth 4 mm.

*Distribution.* Miocene of Ceylon.

### Family Callyodontidae<sup>1</sup>

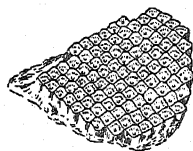
Front teeth more or less united to form a parrot-like beak. Palate edentulous. Pharyngeal bones with a tooth mosaic, lower bones fused. Food chiefly vegetable matter and invertebrates such as corals and molluses.

#### genus **Callyodon** Gronow 1763

*Callyodon* Gronow 1763 Zoophylaceum.

Jaw teeth coalesce completely, forming a mosaic-like surface, edges of teeth even. Canines present or absent posteriorly. One to four sometimes present above or below each side of jaw.

Known from the Miocene deposits of New South Wales.



P. Deraniyagala del.

Fig. 8. Jaw teeth of *Callyodon* sp.  $\times \frac{2}{3}$

#### **Callyodon** sp.

This species is known from a fragment of the left, upper tooth plate; crowns of teeth quadrilateral, and lie in ten rows one way crossed by twelve in the other. Each tooth has a concave crown which rises to an umbo or boss at its uppermost angle while in some the lower angle is rounded (fig. 8).

*Dimensions.* 20 mm. by 24 mm. The longer side of each tooth crown is 2 mm. the shorter 1.8 mm. The greatest diagonal width of the crown is 2.9 mm. and each tooth is about 5 mm. in height.

Comparison of this tooth fragment with teeth of living species suggests that the fish was probably about 1,166 mm. standard length.

*Distribution.* Miocene of Ceylon. Fishes of this genus are common off the fringing reefs of Ceylon.

<sup>1</sup> See Fowler and Bean, p. 372.

Order PLECTOGNATHI

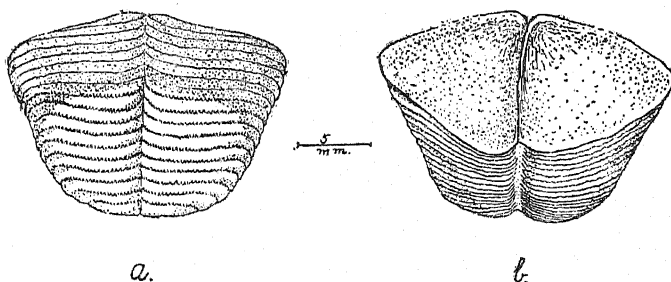
Family Diodontidae

No median suture in either jaw. Teeth of each form a single undivided beak. Usually dental plates present, embedded in jaw bone, with successional ones behind each plate. Skin usually with spines or spinous bony plates. Essentially tropical and subtropical fishes. Food mainly corals, molluscs, and fishes.

genus **Diodon** Linné 1758

*Diodon* Linné 1758. Syst. Naturae.

Body covered with long more or less motile spines. Each jaw with small marginal dental plates and two oblique, symmetrical piles of plates behind. Each dermal spine with two horizontal roots.



P. Deraniyagala del.

Fig. 9. Dental plates of *Diodon sinhaleyus* sp. nov. (type)  $\times 2$

(a) Anterior view (b) Posterior view.

**Diodon sinhaleyus** sp. nov.

This form which is probably intermediate between *Diodon scillae* Agassiz, and *Diodon sigma* Martin, is known from two series of inner dental plates belonging to two separate individuals. Both piles are truncately subconical and possess bluntly angular lateral ridges. The inner face of the pile is flat (fig. 9b). About ten dental lamellae are in wear in each and the total number is eighteen in one pile, sixteen in the other; the full complement probably does not exceed twenty. Each lamellae has a crenulate surface which is in contact with its fellow (fig. 9a).

*Dimensions.* The size of the larger specimens which is the type is as follows: greatest width 20 mm., length of median suture between the

two plates 9.5 mm., height of pile 9.5 mm. The smaller pile measures as follows: greatest width 17 mm., length of median suture 10 mm., height of pile 6 mm.

*Distribution.* Miocene of Ceylon.

The two living species common off Ceylon are *Diodon hystrix* and *Diodon maculatus*.

#### *Conclusion.*

The well defined movements of the islands in Dutch Bay, over a period of forty years, denote that the north-west of Ceylon is far from stable even to-day. Such movements on a larger scale probably elevated, above the sea, a considerable part of this district, for the presence of several salt lakes and peculiar desert tracts suggest that these are relics of the sea, which, during early Miocene times, extended at least eighteen kilometres (eleven miles) inland. Supporting this view are the fish fossils here described, and the presence of such large pelagic forms, as the Pleurotremata, suggest that the *Mālu* deposits were marine and antedated those of lagoon origin which occur especially to the north and east of Ceylon.

### **Appendix.**

Report from the Government Analyst of Ceylon.

#### *North-Western Province.*

- I. Water from Tallawai, Arnamaduwa. Contains chlorides as Chlorine amounting to 1,125 parts per 100,000—distance from sea eleven miles.
- II. Water from Kokaré contains 508 parts of total solids per 100,000—distance from sea ten miles.

#### *Eastern Province.*

- III. The mineral springs at Kanniyai which are only two miles from the sea are as follows:—
 

(a) Cold spring	..	10.23	parts per	100,000
(b) Hot spring (1)	..	10.34	" "	100,000
Hot spring (2)	..	11.85	" "	100,000
- IV. Water from the thermal spring at Maha Oya gave 135.89 parts per 100,000—distance from sea twenty-four miles.
- V. Water from Marangala thermal spring near Kallode gave 110.27 parts per 100,000.
- VI. Water from Andavela bubula, mineral spring near Maha Kumbura gave 27.2 parts per 100,000.

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## On the Breeding and Rearing of certain Species of Primates in Captivity

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(With Three Plates and One Text Figure)

The following notes are based upon my experiences with some species of Primates kept in captivity in Colombo. All except the birth of the Grey Langur took place in my private collection. Further studies are essential on some of the babies, so that the present account is not to be regarded as complete. But the circumstances of the births and the early post-natal growth and development are worth recording. The following items comprise the materials dealt with herein:—

- I. Birth of a Grey Langur (*Semnopithecus priam thersites*)
- II. Rearing of Purple-faced Leaf-monkeys (*Kasi vetulus*) from infancy.
- III. Successful hybridization of the Bonnet Macaque (*Macaca radiata*) with the Toque Macaque (*Macaca sinica*)
- IV. Birth of the Malay Slow Loris (*Nycticebus malaianus*)

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### I. BIRTH OF A GREY LANGUR (*SEMNOPITHECUS PRIAM THERSITES*)

A male baby was born to an adult female Grey Langur in the Colombo Museum Zoo on 10th April, 1936. At that time she was mated with an adult male Western Purple-faced Monkey (*Kasi vetulus nestor*) with whom she had been living for the previous six months. It was therefore presumed that the baby was probably a hybrid, and, although its characters were apparently typical of the new-born pure-bred *Semnopithecus priam*, as far as these were then known, it was

believed that the baby would probably present some paternal features with advancing development. [The birth was reported as that of a hybrid in a footnote in my recent paper on a hybrid Leaf-monkey (1936a).]

The further development of this baby has been closely observed. So far no characters have emerged pointing to its supposed hybridity, and, as the animal is now twelve months old and is quite typical of a pure *Semnopithecus priam* of corresponding age, it is presumed that it will remain so. The question of its paternity has therefore to be reconsidered.

On searching the records it was found that the mother had been mated with a male of her own species prior to her being put with the male *K. v. nestor*. This male Grey Langur had died on 28.IX.1935, and was in the first place, therefore, ruled out as the possible father of the child on account of the long gestation period thus involved, since no sub-anthropoid Primate has a known gestation period of much over six months. The subsequent history of the child, however, demands the recognition of this male as the father, thus giving a gestation period for this species of at least 196 days (seven months). It is, therefore, highly probable that all the *Colobidae* have a longer gestation period than the *Cercopithecidae*. No previous record of the gestation period in any species of the *Colobidae* is known to me. Considering the longer pre-pubertal period (over four years) in this group, it would not be surprising that their gestation period is also longer than in the *Cercopithecidae*.

### (1) Characters of the new-born infant

The characters of the baby immediately after birth are identical with those recently (1936b) described by me for the full-term foetus in this species.

In general form the baby was slender and long limbed like its mother, and was thus a contrast to the more heavily built new-born of the other local genus, *Kasi*. The coat was relatively scanty, but black in colour, as already described for the full-term foetus. The stiff brow hairs were well developed and black. Behind them the frontal radiation could readily be seen, whilst, still further back, was a well marked upstanding crest, black in colour like the rest of the coat. Skin pigment was no more advanced than in the full-term foetus, except for a slight bluish lividity around the mouth. The ears were not pigmented, whilst the callosities were bright pink in colour. The irides were dark brown.

On 7.V.36, *i.e.*, at one month old, the face was definitely blackening, more particularly over the brows. The eyelids remained pale. The ears were a little dusky, but the callosities were still pink. There was no change in the character of the coat. On the 22nd of the same month the whiskers were elongated and white, but had the downward trend characteristic of the Entelloids, and not the lateral elongation seen in *Kasi vetulus*.

By 9.VII.36 the whiskers were quite white, and arranged as in the adult *S. priam*, but the general bodily covering was still the black lanugo coat. The face by now was quite black, and the ears very large and fully pigmented. The lanugo coat was being replaced by the longer, more wiry hairs of the permanent coat by the end of the third month of post-natal life. These new hairs began to show as silvery islands in the black coat, the individual hairs being almost white. They soon exceeded in length the hairs of the lanugo coat, which began to moult during the fourth month. By the end of that month the general bodily colour had changed from black to almost white. The change involved the crest and the hairs on the hands and feet. The crest is a bigger structure in the new dress than in the old. The brow hairs are not changed but grow in length.

The baby is now over twelve months old and has not changed appreciably in appearance since attaining the characters enumerated in the preceding paragraph, apart from growth in size.

## II. REARING OF PURPLE-FACED MONKEYS (*KASI VETULUS*) FROM INFANCY, WITH OBSERVATIONS ON THEIR POST-NATAL GROWTH AND DEVELOPMENT.

Occasionally newly born or very young specimens of the Purple-faced Leaf-monkey (*Kasi vetulus*) have been brought to me, and endeavours have been made to rear them with a feeding bottle. These monkeys are very difficult to deal with, as their alimentary systems are so complicated, and attuned by nature for a special diet, that their rearing has not in all cases been successful. As, however, more recent efforts have been almost or quite successful, I give below the results of my experiences, together with observations made on the growth rate, eruption of teeth and changes in external characters of the individuals concerned.

The account given herewith is based on the following series of animals.



TABLE I. *Details of specimens studied.*

No.	Specimen.	Sub-species.	Sex.	Age when received.	Date of receipt.	Date of Decease.	Period of Captivity.	Cause of Death.
1.	Is.	<i>nestor</i> .	♂	1-2 weeks approx.	13. IV. 33.	End of July, 1933.	3½ months.	Pneumonia.
2.	Hb.	<i>vetulus</i> .	♂	4 months approx.	30. VI. 33.	?	?	Shock following injuries from another monkey.
3.	Dd.	<i>nestor</i> .	♀	3 weeks.	1. II. 36.	11. IV. 36.	2½ months.	Acute gastrictasis.
4.	Ph. 1.	<i>philbricki</i> .	♂	1-2 weeks.	3. II. 35.	4. II. 35.	18 hours.	Malnutrition.
5.	Ph. 2.	<i>philbricki</i> .	♀	2 days.	3. II. 35.	17. II. 35.	2 weeks.	Shock from gun-shot wounds.
6.	Phil.	<i>philbricki</i> .	♂	1 day.	29. VI. 36.	Still alive.	Over 4 months.	
7.	M.	<i>nestor</i> .	♀	3-4 weeks approx.	16. VI. 36.	18. VI. 36.	2 days.	Results of ill-treatment prior to receipt.

Some remarks on the treatment received by each of these individuals and some explanation of certain statements in the above table are necessary.

"Is" was fed from the day of receipt on sweetened cow's milk from a feeding bottle. He did fairly well on this, but did not gain much in weight. He slept a good deal, being wrapped up in old cloth in a dark box. He was always crying and wanting to be carried about by my wife. He caught a chill and rapidly developed pneumonia, which killed him in twenty-four hours.

"Hb" was received during the same period that the previous specimen was in our possession. The two were introduced and were quite friendly, though "Hb" was a much older animal. He was too old for the bottle and was able to feed himself from the start. He subsisted chiefly on fruit, sugar cane, and hibiscus flowers. He is only introduced here because he represents a different subspecies and thus gives some information regarding the racial differences in the early stages.

"Dd" was a very young specimen similar to "Is". She was put on the bottle at once, with sweetened, fresh cow's milk. She soon got used to this and put on weight. Later she was tried on human milk, but having become used to cow's she refused the human with evident disgust. She lived till she was able to eat a fair amount of solid food, but still liked to revert to the bottle about once a day. For several days she was kept completely off the bottle, and one evening, in order to induce sleep a little more readily, she was allowed the bottle. She took too much and died of acute distention of the stomach in forty-eight hours. Personally, I consider this a case of successful rearing, death being entirely due to inadvertence.

The first specimen of *philbricki* was obtained in the jungle after the mother had dropped it in fright when a shot was fired at another member of the troop. The age is estimated as a matter of only a week or two on the basis of comparison with others of known age. It was fed similarly to the last, but, as we were living in a hotel at the time less attention could be paid to it, and a servant was responsible for some of its feeds. The bottle was not always kept as clean as it should have been and the animal failed to put on weight and died in about two weeks.

The second *philbricki* was obtained by shooting the mother. Unfortunately it received itself a few pellets. It was younger than the preceding and died before reaching me.

The third *philbricki* ("Phil") is the most important of the whole series. It was obtained probably within a few hours of its birth, having been picked up in the jungle at Alut Oya, E. P., by Mr. W. W. A. Phillips, the mother having dropped it in flight. Its umbilical cord was still fresh on receipt. It was sent to me by special messenger and was in my hands within twenty-four hours of its capture. I had it put on the bottle with fresh human milk, at once. It took the milk every two hours, day and night for about six weeks, after which the nightly feeds were discontinued. It has grown rapidly, changed its characters markedly, and lived longer than any of the previous specimens. It is still alive and well.<sup>1</sup> It still sleeps a good deal, wants to be carried and fed on awakening but after ten minutes runs off to play. It is not completely weaned yet, but as the supply of human milk is irregular, occasional feeds of cow's milk are given. It is now eating, however, a little papaw, apple or plantain, and likes a lump of sugar or a bit of sugar cane to nibble.

The last individual in the table on p. 372 was a poor specimen. It was rescued from its previous owners who had taken delight in shaving off part of its coat for some inscrutable reason. It took solid food, but was obviously weakly and died after two days. It is only introduced here for comparative purposes.

### General conclusions regarding treatment of newly-born Leaf Monkeys.

The experiences gathered from the above attempts at rearing young Purple-faced Leaf-monkeys, to which should be added some knowledge gained from efforts with two Grey Langur (*Semnopithecus priam*) infants, lead to certain general conclusions.

Firstly, I consider that success is more likely with a newly-born baby monkey than with one already used to its own mother's milk. The first difficulty is overcome, therefore, when the animal is put on to a suitable diet. It must in any case be fed from the bottle until it is four months old, by which time it usually seeks out some solid food, but still requires an occasional feed from the bottle. The baby usually sucks the bottle quite readily, but as the teats<sup>2</sup> do not last long in a tropical climate fresh ones are frequently necessary, and nearly always the baby knows when the teat is different and may refuse to have it. Care is therefore needed in this matter. The hole in the teat must not be too large, or the creature will either choke or get too heavy a

<sup>1</sup> Since writing the above this animal has died (LXII,36) after losing weight for a few days and exhibiting anaemia and slight gastric disturbance. The whole trouble seems to be in the matter of weaning, and the adoption of suitable solid food. With the aid of Dr. Lucius Nicholls I have reached the conclusion that lack of iron and vitamin A and possibly C, are the chief causes of the lack of success.

<sup>2</sup> An ordinary child's teat is too large for a Monkey. We use a "valve" turned inside out.

dose in its stomach for the latter to digest. This gives a heavy clot and may lead to sudden death from acute gastritis or distention. On the contrary the hole must not be too small; a weakly baby may not have the strength to obtain sufficient for its needs.

Whatever food is given, the bottle feed is required every two hours, both day and night in the youngest animals (say the first five or six weeks) and thereafter about four times a day for another month or six weeks. By the end of this period it will usually seek out some solid food and thus alternate the fluid feeds with the solids.

There is no question, I think, that, failing its mother's milk, human milk is best for the young of any sub-human Primate, but, whereas a hardy species, such as a macaque or a baboon, will allow of more latitude, I do not think that much success with any Leaf-monkey can be expected. Only one of ours was really satisfactory in its progress on cow's milk, and that one eventually died of an overdose of it. Human milk is rarely obtainable in sufficient quantity or with unfailing regularity, but the diet should, if possible, consist of this alone. Failing the above regime human milk, supplemented, or even mixed with, diluted sweetened (*i.e.*, "humanized") cow's milk may be given. The amounts taken are very small at first being only perhaps 1/2 to 1 oz. but as the baby grows, amounts up to four ounces may be taken at a feed.

### **General observations on Post-natal growth and development of Purple-faced monkeys**

*Growth.* The specimens mentioned in the foregoing paragraphs include a sufficiency for the formulation of some general statements regarding the rate of growth and post-natal development in the species *Kasi vetulus*. Accurate regular records of the total body weight have been taken of all those individuals that lived for several months.

The first specimen in the table, "Is", weighed 480 gms. when received. He increased on an average by 14 gms. (half an ounce) per day for the first two weeks, but thereafter, he added but little; due, no doubt to the fact that his diet was not an adequate one for further normal growth.

"Dd.", the next specimen studied over a prolonged period, weighed 415 gms. on receipt. She was weighed daily for the first ten days and found to increase at once at the rate of 5-10 gms. per day. Apart from minor variations the weight progressed favourably, until, at death, at the age of approximately three months and after two and a half months captivity, she had attained 600 gms. The rate of weight increase is thus much the same as in the last specimen. Details are given in the accompanying growth curves.

# GROWTH CURVES OF KASI VETULUS

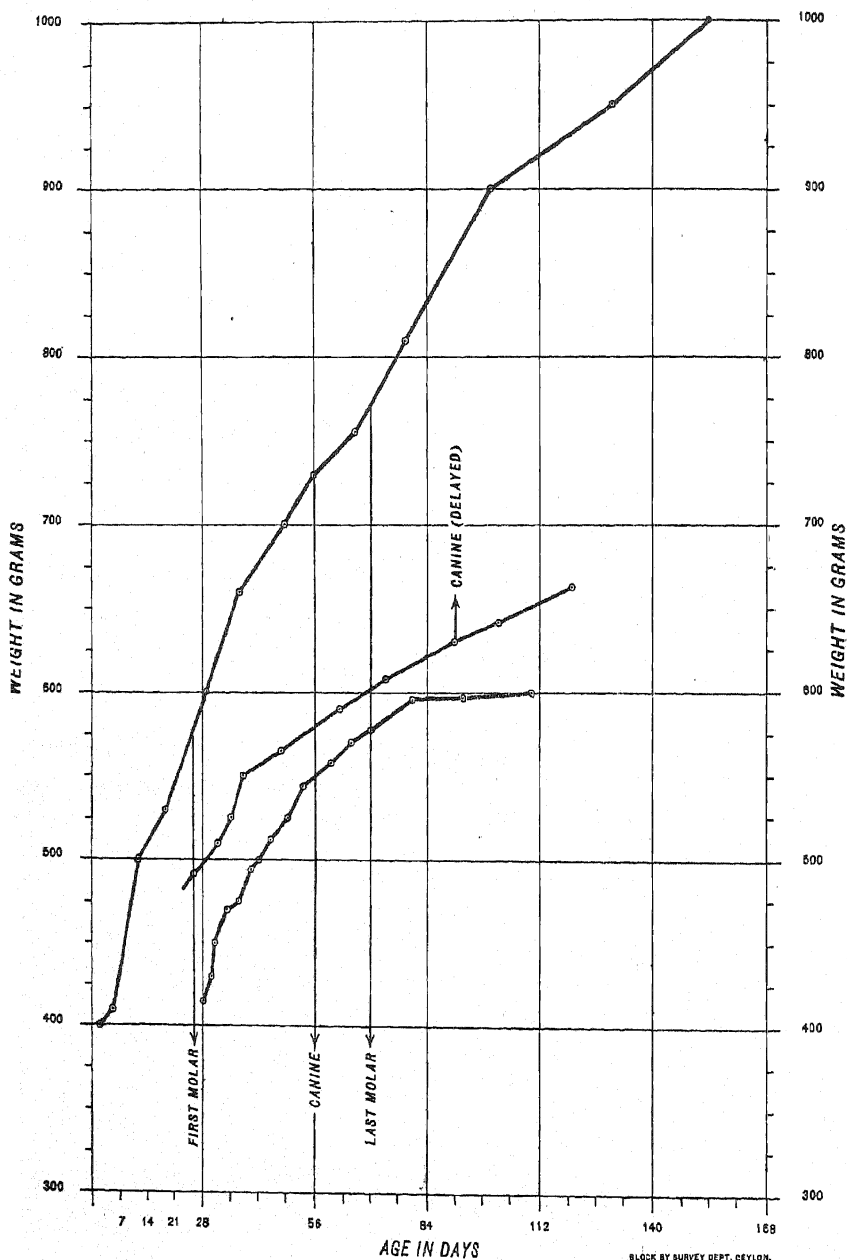


Fig. 1. Growth curves of three infantile Purple-faced monkeys

Upper curve represents growth of "Phil". Below this is the curve for "Dd", and lowest that of "Is".

"Phil," the remaining individual whose weight has been systematically recorded, weighed 360 gms. at the time of receipt. This may, with safety, be regarded as the birth weight. He increased 40 gms. on the first day and by 10 gms. the next three days, but thereafter more rapidly as indicated in the growth curve. His increase was fairly uniform till the end of the third month. During the fourth month the weight remained relatively stable. At the end of this time ostelin was administered about twice a week and since then the weight has commenced to increase again, and at the time of writing he weighs about 1,000 gms., which is probably normal for his age.

*Eruption of Teeth.* The following observations, on order and rate of eruption of the temporary teeth, have been made on this series of animals. At birth the gums show no evidence of tooth eruption, but all the milk teeth are formed within the alveoli. Only one of the specimens ("Phil") showed this toothless condition of the gums on receipt, so that the order and times of eruption are best given first for that specimen, and the others compared with it.

Allowing the animal ("Phil") to be two days old, at most, on receipt, then the first teeth to appear through the gums were the central incisors which appeared on the fourth day. The upper and lower teeth made their appearance at the same time. The lower lateral incisors were first visible on the next day, and the corresponding upper teeth the day following. At the age of one month the first molar crowns were coming through in both upper and lower jaws. These were followed exactly a month later by the lower canines. At this time the first molar crowns are still incompletely erupted, and the second molars are not visible. The upper canines follow speedily on the lower. The last teeth to appear are the second molars. These are just visible in both gums two weeks after the eruption of the lower canines.

Of the other two specimens, "Is" had all eight incisors and the first molars erupted when received. This places it at the age of over one month judged by the above. Six weeks later no more teeth had made their appearance, the upper and lower canines appearing during the ten days following this and being still incompletely erupted when the animal died. The second molars had not appeared at this time.

"Dd.", judged by its dentition, was the same age as the preceding on receipt, for it already possessed eight incisors and four first molars. Its canines appeared one month later, thus agreeing with "Phil." The last molars appeared two weeks after the canines.

From the above it would seem fairly certain that the incisors appear during the first post-natal week, followed at about the age of one month by the first molars. Another month brings up the canines and these are succeeded by the remaining molars in another two weeks. Thus the baby Leaf-monkey accomplishes in two and a half months what it takes a human child two and a half years to attain. The only discrepancy in this series of monkeys seems to be the delayed eruption of the canines in "Is." The order of eruption is the same as in the human infant, but the precocity of the mandibular over the maxillary teeth is less marked.

The history of milk-tooth eruption in these monkeys is therefore much shorter than that given by Schultz (1933) for the Rhesus Macaque,—the only other monkey that has been studied in this connection.

*Progress of Pigmentation.* At birth the only pigment present in the skin is a little on the hands and feet. Here it may be confined to the dorsum of the fingers, with their nail beds, but soon spreads to the palms and soles, where, for a time, it may have a patchy distribution. The face, ears, callosities and hair covered areas are quite without pigment. In the face, pigment commences to deposit in the centre of the upper lip and on the lower part of the nose on the fifteenth day. It spreads from here and forms a dusky patch all over the muzzle leaving the orbital region and eyelids pallid. A dark band is also formed beneath the brows and becomes united to the muzzle patch by a narrow tract along the median ridge of the nose. As the pigment increases it changes from dusky to a livid lilac, darkening after a couple of months to blackish purple. Meantime pigment has been depositing in the ears, where the colour goes through the same phases as in the face. The hands and feet also darken to a more sooty black and the deposit in them becomes more uniformly distributed. The callosities and genitalia remain pink or pinkish-white until the age of three and a half months, when a little brownish pigment commences to deposit in the ventral borders of the callosities. No body pigment has developed in the oldest of the present series, except for a few patchy areas on the scalp of "Phil." In "Hb", the oldest of the series under discussion, there is no further pigment present than is found in "Phil". Pigmentary subspecific differences evidently become manifest only during later growth.

*Development of the hairy coat and its colour pattern.* All Leaf-monkeys at birth are clothed with a downy coat of lanugo. This coat is short and the individual hairs are fine and silky in texture. The skin, however, is readily visible, on parting the hairs of the coat. Only

the face, ears, callosities, and palms and soles are naked, but the hairy covering is more plentiful on the scalp, nape and upper back than elsewhere in *Kasi*. The whiskers are very short and closely applied to the sides of the head at birth, but the brow hairs are relatively long and stiffer than the other hairs of the lanugo coat.

The lanugo coat is gradually replaced by the permanent coat. This is a denser coat consisting of longer, coarser hairs. These first appear as isolated hairs proceeding out through the lanugo, and, gradually increasing in number succeed in completely masking the lanugo coat, which meantime is being shed. It now becomes difficult to see the skin on parting the coat, so great is the density of implantation of hairs. The permanent coat does not appear through the lanugo at all points in the body surface at the same time. The order of appearance is as follows. First a few scattered hairs on the scalp and nape, succeeded by islands on the upper back and outer aspect of the arms and thighs. The lower back, tail and distal parts of the limbs develop their permanent coat later, whilst the ventral surface seems to be the last to undergo the change.

In all Leaf-monkeys in which the full story is known, with the exception of *Kasi johnii* of the Nilgiri Hills, the lanugo coat is strikingly different in colour, or pattern, or both, from the permanent coat; and this fact has served as a basis of classification for the whole group. In the Purple-faced Monkeys (*Kasi vetulus*) the lanugo coat is always lighter in colour than the permanent coat, but the degree of difference varies subspecifically. Another important fact is that in the lanugo coat the dorsal surface is darker than the ventral—a primitive feature—whilst in the adult type the ventral surface is as dark as, or darker than, the dorsal. In the subspecies *philbricki*, constantly, but less noticeably in the other races, there is, in the lanugo coat, definite evidence of a colour pattern on the dorsal surface. This pattern has the arrangement known as the “*cruciger*” pattern, on account of its persistence in adult life in the Bornean species of that name. As seen in new-born specimens of *philbricki* this pattern consists of darker markings on a lighter ground colour. Two dark paramedian stripes, separated by a median pale stripe, occur on the dorsal surface of the trunk from neck to tail. Across the shoulders is a transverse black band fading out on the extensor aspect of the arms. The occiput and nape are pale and separated, anteriorly, from another pale sincipital area by a slightly darker coronal band stretching between the ears. The sinciput, however, is not so pale as the occiput. Details regarding coat colour in both lanugo and permanent coats are best discussed in the following section.



### Subspecific variations during Post-natal Growth.

The following remarks apply to the southern, western and northern (*vetulus*, *nestor* and *philbricki*) subspecies of *K. vetulus*, the highland form (*monticola*) not yet having been studied.

At birth and during the period when the lanugo coat is in evidence, the subspecies *nestor* and *vetulus* are scarcely distinguishable. Both are clothed with a lanugo coat of light silvery grey hair, paler, almost white, below and on the flexor surfaces of the limbs. The individual hairs are white at the base, but a varying amount of black occurs in the tip of each hair giving a general grey effect. The scalp is the same colour as the back, but the hands and feet are generally much darker, inclining to black. The amount of black on the hands and feet tends to be greater in *vetulus* than in *nestor*, but otherwise they are indistinguishable until the permanent coat is well established. *Philbricki*, on the contrary, is better differentiated. At birth it is almost white all over, with only the minimum of black tipping on the hairs. The amount of pigment soon increases, however, and gives a silvery grey effect similar to the other two races, but with a constant tendency to produce a "cruciger" pattern. The scalp however, remains white much longer, except for a transverse coronal band of varying width. The occipital area, though darkening with age, remains permanently paler than the rest.

With the development of the permanent coat the subspecific characters emerge more distinctly. In *vetulus* and *nestor*, pale hairs appear on the lower back and sacral region with a patchy distribution at first. These patches eventually fuse and form a single area, on which the hairs are not only shorter but paler than elsewhere. In *vetulus*, the area affected is larger and more distinctly marked off from the surrounding dark hairs than in *nestor*. In *philbricki*, although the hairs on the lower back are shorter and later in appearing than elsewhere, they have not developed into a pale patch in the oldest specimen so far examined. The same would certainly be the case with *monticola*, where the patch is normally absent even in the adult. The rest of the dorsal surface of the trunk becomes increasingly dark, ending up with a leaden grey in *nestor* and *philbricki*, but black in *vetulus*, relieved, however, by a varying degree of frosting of the tips of the hairs in the last named. This frosting is absent in the other races. The ventral surface eventually becomes black without any frosting, in all three races.

The scalp region also develops somewhat differently in the different subspecies. In *nestor*, a more or less uniform earthy tint is gradually

produced by fading of the original grey. It is often paler behind than in front. In *vetulus* the brownish tinge is typically darker, but there may be some paler, almost buff, hairs posteriorly. In *philbricki* the cap is pale, with a darker coronal area persisting in some specimens. In some too the occipital area may remain almost white.

The tail differs to some extent in the three races under consideration. Whilst the lanugo coat is in evidence the tail appears more bushy, especially in the distal third, than after the growth of the permanent coat. This bushy character is best marked in *philbricki*. In the lanugo coat the tail is uniformly coloured, but in *philbricki* the white tip becomes evident with the appearance of the permanent coat.

There are no pigmentary differences between the infants of the three races considered here. The suggested distinction, mentioned in an earlier paper (1936a), on the face of the young of *philbricki*, turns out to be a question of age rather than race, as mentioned in the preceding section of the present contribution.

### Physiological Considerations

In concluding this account on the post-natal changes in *Kasi vetulus* a few notes on some physiological and behavioural phenomena may be of interest.

The umbilical cord, which was present and quite fresh in specimen "Phil" on receipt, gradually dried and sloughed off eleven days afterwards.

Most of the time, until the infant is four months old at least, is spent in sleep. The baby wakes up when hungry and cries for its mother, or nurse, and keeps crying till its hunger has been satisfied. New-born specimens then go to sleep again after exercising their limbs by curious wriggling, or athetoid, movements similar to those observed on a human child of corresponding age. The baby cannot stand or walk until it is about a month old, although it may make efforts to stand before this. Its first efforts are very ineffectual and inco-ordinate. Once it has learned to use its legs, it runs a little way and then returns to its keeper. Gradually it takes longer excursions, returning always on alarm. At the age of three to four months and onwards, it will play with other monkeys of its own age or even with dogs. It learns to climb too during this period, and to leap from one chair to another.

The eyes of new-born infants have a curious stare similar to that of a human child. Accommodation is definitely undeveloped and inco-ordinate movements of the eyeballs are to be noticed. Accommodation

was developing but not perfect in "Phil" at twelve days old. The senses of hearing and touch are quite acute, but smell and taste would be difficult to test accurately.

The voice is a sharp, feeble whine at first, and, if its wants are not satisfied, can be very persistent. During later infancy, all the specimens I have observed have developed a peculiar note when spoken to in a loud or angry voice, and when a stranger has entered the room. This is a curious staccato chatter which I have never heard from a grown up individual. No use is made of the laryngeal pouch until puberty.

Meals are required every two hours, both day and night, for the first few weeks, only about an ounce, or at most an ounce and a half being taken at a feed. Later larger quantities are taken at smaller intervals. The bowels are moved half a dozen times a day for some weeks, later only about half that number of times. The faeces are semifluid and creamy to yellow in colour with an odour similar to that of a human infant. The colour becomes greenish to brown with the transition to solid food, and the consistence less fluid.

In conclusion I have to acknowledge my gratitude to my wife who has spent much time and trouble in nursing and caring for the babies mentioned in this paper, often with frequent nocturnal interruptions. I also have to thank the Matron of the Lying-in Home, Colombo, for supplies of human milk.

### III. ON A HYBRID BONNET MACAQUE (Plate XVIII)

Both Flower (1929) and Zuckerman (1931) record the births in the London Zoo of a number of hybrid Macaques, including one which was a cross between the South Indian (*Macaca radiata*) and Ceylon (*M. sinica*) forms of Bonnet Monkey. No description of such a hybrid, however, has been published. The birth of a female hybrid between these two species in my own collection of living Primates enables me to supply this deficiency.

The mother of the baby is a typical specimen of the dry-zone race, *Macaca s. sinica*, of Ceylon Bonnet Monkey. She has always been a good breeder and a careful parent. Whilst she has been in my possession she has regularly given birth to a child each year, when given a suitable mate. Her three previous children were pure bred.

The father of the hybrid is a full-grown specimen of the typical race of *M. radiata*. He was kept with another (younger) female *M. sinica* for some years, but without effect.

The hybrid baby was born during the night of 27/28th June, 1935. It is therefore now over eighteen months old, and, as no further gross changes in its characters may now be anticipated, it seems warrantable to assume that its present characters may be recorded as the permanent effects of the hybridization.

### Early Life of the Hybrid

When born the baby was rather small. Its skin was devoid of pigment. In general colour its coat was blackish brown, a colour which appears common to the new-born infant of most species of Macaques. There was, however, a slight rusty tinge in the middle of the back. The face was naked, flesh-coloured, and wrinkled. The eyes had bluish sclerotics, and the iris was also blue. The ears were large, naked and a clear whitish flesh-colour. The fore part of the scalp was quite naked, and the bonnet therefore confined to the hinder part. The hairs of the bonnet were arranged as in the adult *M. radiata*, and not as figured (Hill, 1932) in the normal new-born Bonnet Monkey. There were some sparse hairs on the cheeks, but these were too pale and inconspicuous at this stage for their direction to be made out with certainty. The forearms were very scantily haired, and the dorsum of the hands and feet quite naked, the same as the palms and soles. The tail, too, was very sparsely haired.

At the age of one week some brow hairs had made their appearance. These were arranged as in *M. radiata*, the hair-streams being interspersed by a number of transverse wrinkles. These extended out as far as the front of the bonnet. It was still impossible to make out whether the pre-auricular hairs were arranged as a whorl (as in *sinica*), or as a simple upgoing stream (as in *radiata*). A day later the mother was teaching the infant to sit up and the baby was trying to reach out to touch objects. A few days later the baby was making sounds as if trying to communicate with its mother. By the end of two weeks "lip-smacking" had been learned. At this time no teeth were yet visible in either jaw. The external genitalia were similar to those of a normal female Macaque, and included the scrotal-like swellings recently noted by Wislocki (1936) in *Macaca mulatta*. There is a difference, however, in the swellings in Bonnet Monkeys from that figured for the Rhesus Monkey. In the latter the scrotal fold lies transversely, but in Bonnet Monkeys it takes the form of paired folds lying parallel to one another, in the long axis of the body. The result is even more like a scrotum than in the Rhesus, so much so that, on seeing it for the first time in a new-born Bonnet Monkey, I believed that I was dealing with an instance of pseudo-hermaphroditism.

At three weeks old a few black hairs had developed on the ears, and some yellowish wash was evident on the flanks. A few stiff, black brow hairs were present also at this time, but they were very fine in texture. The baby was making essays to sample solid food at this age, and was also capable of standing unassisted. The two lower central incisors were seen for the first time five days later, but no other teeth were present, in fact the corresponding upper teeth were not actually seen till another month had elapsed, by which time the lateral pair of lower incisors were also through the gum. •

At the age of seven weeks the pre-auricular hairs were sufficiently distinct to enable their arrangement to be made out. This was in the simple fashion associated with *M. radiata*, and not in the whorl-like form found in *M. sinica*. At this time the forearms had become more hairy, but the colour of the coat was quite unchanged. Four days later the first signs of pigmentation commenced, and this consisted chiefly of the sky-blue tinge on the sparsely haired ventral surface of the trunk. Pigment was absent from the face, ears, shoulders, arms and legs, but the palms and soles were a little dusky. The iris was still bluish.

No obvious further changes were noted after the above, apart from the fact that at the end of four months the canines were erupting both below and above, and therefore the first molars had meantime also presumably made their appearance. Two weeks later showed the presence of much more yellow ticking on the flanks and mid-dorsal region, whilst the colour of the iris was changing to olive though still showing a bluish tinge for several months after this.

### Present Condition

The hybrid is now over eighteen months old and has developed no further important changes in character beyond those already enumerated. No pigment has developed in the lips or ears; the bonnet has not altered its form; the cheek-whorl has not become modified and the colour of the coat is much as it was at three months old with some increase in the yellow wash. It is very evident therefore that the animal betrays plenty of evidence of its paternal parentage, and scarcely anything to indicate that its other parent was a Ceylonese animal. The only feature at all indicative of the latter parentage is the yellowish tinge on the shoulders and flanks; but this would, itself, be very inconclusive evidence unless its parentage were actually known, for many female specimens of *M. radiata* show some yellowish ticking on these parts. The only genetic conclusions that can be drawn from

this single experiment are that the specialized characters of the Ceylon species (*e.g.*, the more complete bonnet, the pre-auricular whorl and the extensive pigmentation) are not dominant to the more generalized characters (incomplete bonnet, simple pre-auricular hair-tract and lack of facial pigment) of the South Indian Macaque. Coat colour, as in man, is probably the result of several hereditary factors.

#### IV. BREEDING OF *NYCTICEBUS MALAIANUS* (Plate XIX)

Little information can be elicited from the literature regarding the breeding habits, post-natal development and behaviour of the Slow Lorises (*Nycticebus*). Shelford (1917), in whose valuable work on Bornean animals I expected to find some notes on this subject, says nothing whatever. Wood Jones (1926, 1929) apparently kept live specimens in captivity and among them a baby is mentioned. It was evidently not born in captivity, but the remark is made that the baby clings to its mother's fur, whilst parental care is affirmed to be non-existent. Banks (1931) noted that only one young is produced at a birth in the Bornean form (*N. borneanus*). Zuckerman (1932) collected most of the available information on this genus, basing his observations on the Hubrecht collections and records. These gave evidence that pregnant specimens had been recovered in all months of the year except July, so that presumably the species has no definite breeding season as has been shown to occur in *Lemur*, and as is also believed to occur in its nearest relative *Loris*. There was, however, a relatively greater number of pregnancies towards the end of the year, indicative, according to Zuckerman, of a relative increase in fertility in the later months of the year. Harrower (1933) also kept live specimens in captivity, and on one occasion had a female brought to him carrying a half-grown baby. It must frequently happen, as with the Slender Loris, that females are captured carrying babies at various stages of development. It is extremely important that records should be kept of such events, and also that the state of development of the baby should be noted. This is especially the case, since it is known that the babies, in all Lorises, are carried for a considerable time (several months at least); even after they have ceased being fed by the mother's milk. Mere records of mother's carrying babies are therefore insufficient in the estimation of evidence in favour of the occurrence of a breeding season or otherwise. Such an estimate should only be based on mothers carrying babies of the same stage of post-natal development. Again, as with *Loris*, it must also happen sometimes that pregnant females

are brought in alive and give birth to their babies in captivity. No record of such an event, however, occurs in the literature. The first instance I came across was a birth that took place in the Dehiwela Zoo near Colombo. The baby was born in February, 1933, but died in a few days. The mother lived for some years afterwards in my own collection, but, having no male, no further records could be made. Having recently kept both sexes of the Slow Loris for sometime in captivity and two births having occurred I append below some observations thereon, in the hope of filling some of the gaps in our knowledge of the reproductive physiology of this genus.

### Gestation.

On October 16th, 1935, I obtained, through the kind services of Mr. W. J. C. Frost, two adult pairs of *Nycticebus malaianus*, procured by him in Singapore. One of the females (A) showed some abdominal enlargement after a week or two and it was tentatively assumed that she was pregnant when captured. The other (B) did not show any enlargement of the belly, but unexpectedly gave birth to a baby on the 27th November, 1935. This one was, therefore, undoubtedly pregnant on arrival. The first female (A) did not give birth to her baby until 14th January, 1936, nearly two months after the first indication of abdominal enlargement. There is just a possibility that in this case the whole pregnancy had been experienced during the period since capture, or even after the animal had come into my possession; but, in view of the obvious abdominal enlargement so soon after arrival, I am very much inclined to doubt this. Besides, the known facts regarding pregnancy in the Slender Loris (Hill, 1935) afford additional support for the view that the pregnancy had already commenced prior to mid-October, 1935. Taking this to be the case, the gestation period is inferred to be at least over three months. Otherwise, from the case of the female (B), a gestation period of over six weeks is all that can be inferred. The higher figure agrees better with the facts known concerning *Loris*.

### Parturition

In all the three cases that have come under my observation there has been only one baby produced at a birth. Parturition in each instance took place during the night, and was not actually observed. In one case I saw the baby very early next morning, when it could only have been an hour or so old; it was still wet, and the mother was washing it.

It was not clinging to the mother, and did not do so for an hour or more. No evidence of the placenta was found; it had, presumably, been eaten.

### Post-natal Behaviour of Mother and Baby

My experience agrees with that of Wood-Jones in that I found the mother always resented interference with the child. Attempts to pick up the child were always prevented for the first two months, but after that it was not so difficult, though the baby always struggled and clung with a powerful grip to its mother, if she was handy, or to other solid objects if she was not. In clinging to its mother I did not observe that the baby ever normally adopted the reversed posture mentioned by Wood-Jones (1929). During the day time it slept in any position, but mostly with its head on the mother's pectoral region, whence it took long and frequent feeds from the nipples. As it grew older the feeds were less frequent, and the baby was not so particular as to its position on the mother. Sometimes it would be found asleep on her back, or even on that of the male that was kept in the same cage. Lactation continued for at least six months, though it was difficult to determine when it really ceased. The baby commences sampling solid food, including insects, at the age of ten days, but naturally it depends upon its mother's milk for the major part of its nourishment for some considerable time after this.

I have noted considerable differences between the maternal relation to its offspring in *Nycticebus* and *Loris*. Wood-Jones (1926) says that, beyond resenting interference with her offspring, the mother *Nycticebus* cares but little for it, and trusts to the baby's powers of grip rather than assisting it to maintain its position on her belly. If the baby is taken away, or gets away accidentally, the mother is said not to be troubled thereby. I have found all these facts to be true of *Loris*, but my experience with two cases in *Nycticebus* has not been this. A mother *Loris* takes no more care of her child than to feed it and allow it to hang on, and to give it its daily toilet. It is true that she resents interference by growling and biting, but then she does this whether she has a baby or not. If the baby is removed from her she does not trouble to take it back again; and if it is placed back purposely she will even throw it away. This is very strange considering how she will put up with a child nearly as big as herself long after she has finished lactating. The new-born *Loris* is very helpless, and if discarded by the mother, quickly dies. It could not possibly stand alone, still less climb, for a couple of months at least. *Nycticebus* on the other hand gives birth to a relatively sturdy infant which she will deliberately place



on the ground on the first day, and which makes efforts to stand alone, and even walk on the ninth day. She will rush towards the baby and pick it up if danger threatens, and place it down again when the risk is over. She will leave her own food to do this. If the baby is marooned it squeaks for its mother, and she will try to get to it if she is able. If the baby is picked up for observation and replaced, she does not discard it, but smells it, licks it clean, and allows it to go to sleep again.

### Post-natal Development

The baby *Nycticebus* grows rather rapidly. One of my specimens weighed 60 gms. on the third day and had increased to 95 gms. in the first two weeks. The other, which was slightly larger at birth, weighed 165 gms. at the age of two months. The former baby lived for nine calendar months and weighed 270 gms. at death. The other one lived for eleven months and weighed 350 gms. after death. Both died of a pellagra-like condition, involving little or no wasting, and probably caused by some dietetic error,—a subject upon which I hope to make some statements elsewhere in the near future.

In appearance the baby *Nycticebus* (Plate XIX) resembles its mother very closely from the first, and depends more on the colouration of its own coat than on the length of its mother's for concealment. Its coat colour is thus a rusty brown or sandy tinge, with the dorsal stripe and the dark circumocular areas less well marked than in the adult. The limbs are paler, but well-haired to their distal extremities. No observations on the eruption of the teeth could be made during life. Both the babies had at death a full complement of permanent teeth. In both there were four incisors in the upper jaw, but the lateral pair was rudimentary. The central pair are separated by a wide gap in the midline. In this gap the gum is swollen towards its palatal margin. Upon this swelling is a pit, apparently blind, which might be mistaken for a tooth alveolus. It is probably connected with the organ of Jacobson. The remaining teeth resembled those of the adult. The sublingua is very well developed in both babies. Neither of the infants is absolutely tailless, one having a stump 14 mm. long, and the other one of 6 mm. The sexes are very difficult to determine. The genital tubercle is similar in size and appearance in both sexes. The female is recognized by the transverse slit-like vagina at the root of the genital tubercle, but this is small, tightly closed, and buried among the woolly hair. The testes are not in the scrotum, and probably, as in *Loris*, only descend periodically in the sexually mature male.

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## EXPLANATION OF PLATES

## PLATE XVII

Post-natal Changes in *Kasi vetulus philbricki*

Fig. 1. Male at two days old

Fig. 2. The same individual at two-and-a-half months old

## PLATE XVIII

Photograph of a hybrid female Bonnet Macaque (*Macaca radiata* ♂ X *M. sinica* ♀) at the age of nineteen months

## PLATE XIX

Photograph of a young male Slow Loris (*Nycticebus malayanus*) at the age of nine months

*All blocks illustrating this Part by courtesy of the Survey Department, Ceylon, except where otherwise stated.*





Fig. 1

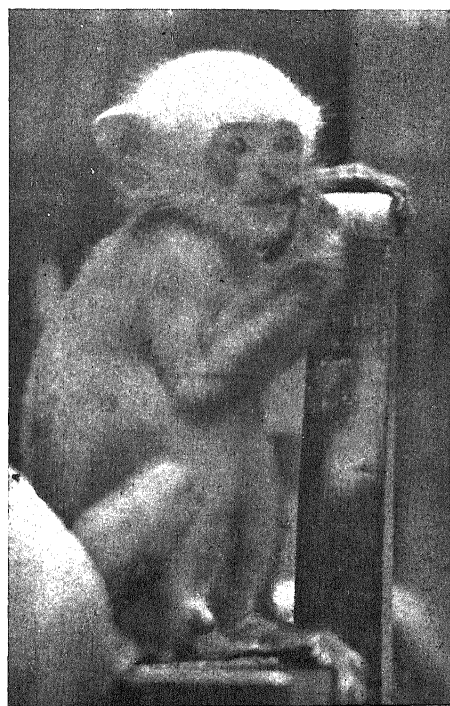


Fig. 2

Two Post-natal Stages of *Kasi vetulus philbricki*





Hybrid Bonnet Macaque, ♀





(Block kindly lent by Ceylon Game and Fauna Protection Society)

*Nycticebus malayanus* Anderson, male juv., nine months old; born in captivity





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